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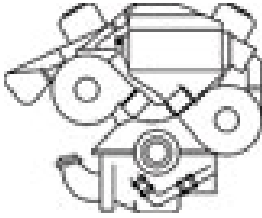
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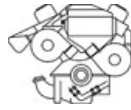
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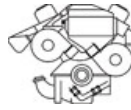
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A PROTOTYPE DESIGN OF A DEDICATED SMART HOME ENERGY MANAGEMENT SYSTEM

Fawzi M. Al-Naima

Al-Kut University College, Wasit, Iraq, and

Department of Computer Eng., Al-Nahrain University, Baghdad, Iraq

<https://orcid.org/0000-0003-0930-5073>

Hassanain H. Kareem

Department of Computer Eng., Al-Nahrain University, Baghdad, Iraq

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Abstract

With the continuous rise of electrical energy costs for heating, cooling, and ventilation and the increasing number of energy-consuming home appliances, designing a cost-effective efficient residential electric energy management system has become crucial. This paper presents a prototype simulated design of a Smart Home Energy Management System (SHEMS), dedicated to the management of residential electrical energy according to the user-preassigned comfort requirements and cost criteria. All planted sensors and home appliances are controlled by one master microcontroller. The Proteus Software ISIS was used for all simulation results. The proposed application collects information from sensors to control the required home appliances by switching them ON or OFF based on a specified design algorithm. The sensors' assigned values and home appliance status are stored in a main database. The proposed design also allows home appliances to be monitored and controlled remotely via the Internet. Simulated results are given for a two-room residential home.

Keywords: Smart home, home automation, remote controlling, system management, Web applications, Proteus ISIS

1 INTRODUCTION

With a Smart home energy monitor, you can save money and ensure that your home has the most efficient energy use possible. Nowadays it is of great importance to lower power consumption because of environmental concerns and energy

costs. A system to achieve this goal can substantially reduce the users' responsibility for action. Therefore, greater comfort can be reached while at the same time contributing to environmental protection (Kofler & Kastner, 2010). For the next few decades, the two major problems concerning energy are the greenhouse effect and the depletion of petrol resources especially the energy provided by oil and gas. Therefore, the need for another resource of energy such as wind or solar became a very important aspect. The role

Address of the corresponding author:

Fawzi Al-Naima

fawzi.m.alnaima@nahrainuniv.edu.iq



of a smart home dedicated to power management is to adjust the power consumption of the available power resources taking into consideration user comfort criteria. A smart home energy management system must reach a compromise between the priorities of the user in terms of comfort and cost while satisfying technological constraints (Golzar & Tajozakerin, 2010). On the other hand, due to the significant development of the Internet and computer technology, the Internet became a substantial element as a medium used in home automation systems, providing many features ranging from efficient use of energy to increase comfort (Gu, Diao, Liu & Zhang, 2011), (Bos, Chmielewski, Hoepman, & Nguyen, 2007). Along with the mobile phone's popularization and the radio control technology's maturity, getting information about home status based on GSM network service and wireless communication via SMS message is to become a proper choice, because it gets rid of the fetter of wires, and meets the application need conveniently with a lower cost (Yang, Zhang, & Sun, 2010). Intelligent home system design has become one of the favorite current research topics

for the scientific community worldwide. This paper will present the design and development of simulation algorithms for a residential home automation controlling system.

2 PROPOSED SMART HOME ENERGY MANAGEMENT SYSTEM (SHEMS)

The general architecture of a designed control system is shown in Fig. 1. The home can be monitored via a PC which is connected to the controllers through a serial port (RS232) as well as a home-based web server that can be accessed from anywhere in the world after logging in successfully. This architecture has been adapted with modifications from the work done by (Golzar & Tajozakerin, 2010). Many improvements were added to the original architecture. The auxiliary controller is added for security purposes. The GSM network has been added to the architecture because it is a proper choice and meets the system's needs at a lower cost. The GSM network can also send information to homeowners about their home status via SMS message.

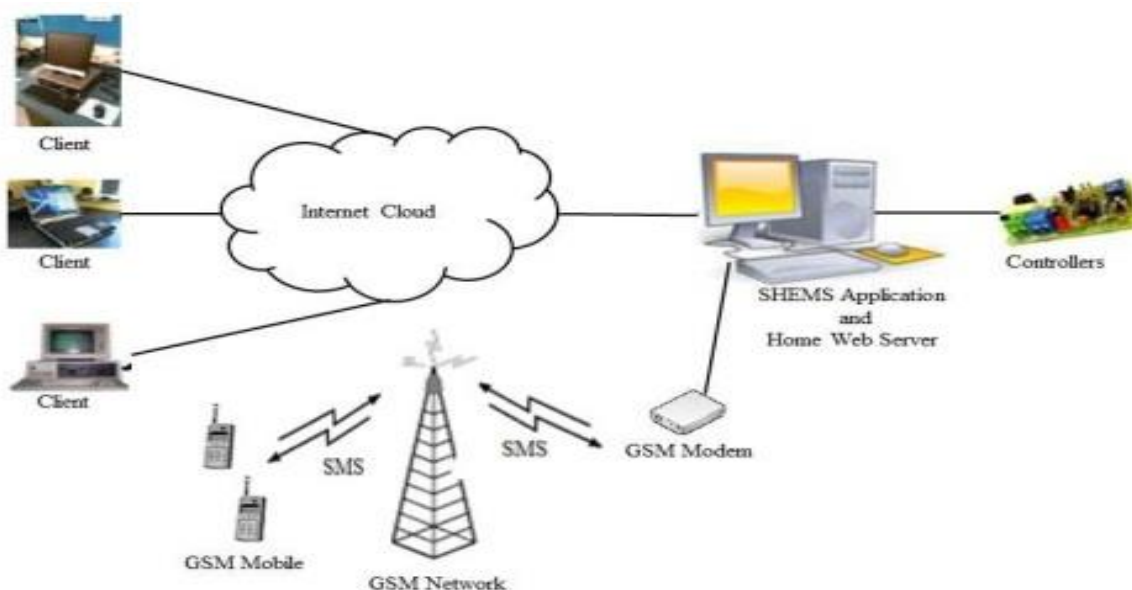


Fig.1 General Architecture of the Proposed SHEMS

2.1 Design components

ATmega32: This microcontroller has been used due to the availability of built-in ADC pins. It is programmed by WinAVR software because of its simplicity and ease of use (Atmel Corporation, 2003).

Motion Sensor: This Passive Infra-Red (PIR) pyroelectric device detects motion by measuring changes in the infrared levels emitted by surrounding objects. It is used to determine the presence of occupants inside their premises (Al-Arif, M.R., Kadir, Morshed, Ferdous, Alarm, &

Haque,2011), (Texas Advanced Optoelectronic Corporation, 2007).

Temperature Sensor: The LM35 is a precision integrated-circuit temperature sensor, with an output voltage linearly proportional to the Celsius temperature and can be used to measure the temperature (Al-Arif, M.R., Kadir, Morshed, Ferdous, Alarm, & Haque,2011), (Parallax Inc., 2005).

Light Sensor: This TSL251RD family of sensors converts light intensity into voltage. These devices simplify the design by integrating a photodiode and a trans-impedance amplifier on a single monolithic IC. This family provides a linear output voltage that is proportional to the light intensity (National Semiconductor, 2013).

Door Sensor: The door sensor is a magnetically operated reed switch. This type of switch is chosen since it is easier to accommodate the loose mechanical tolerances of the door movement. The magnet is placed on the door and is close to the reed switch when the door is fully closed the signal is grounded. When the door opens, the magnet moves away from the switch, the switch is opened and a high signal is detected (Atmega Editor, 2012).

Charge sensor: This sensor is used to measure the charge of solar cell batteries. A 12 V sealed lead-acid battery provides different voltages depending on its state of charge. The output has a voltage of 12.6 V when "Full" and 11.6 V when "Empty". The battery's charge state can be

measured using a voltage divider circuit because the maximum voltage of the microcontroller input pins is 5 V (Pavlov, 2017).

Keypads, LCDs, Relays, and many other devices are also used to build the hardware. Simulation tools using Proteus ISIS software are also used to simulate the circuit (Proteus, 2020). The software is used to draw schematics and simulate the circuits in real-time. The simulation allows for human access during run time, thus providing real-time simulation.

2.2 Hardware subsystem

The hardware architecture of the proposed SHEMS is composed of two microcontrollers; a central controller and an auxiliary controller, selected from the AVR family (ATmega32), (Atmel Corporation, 2003).

The Central controller: The basic idea of the central controller is derived from the work done by (Golzar & Tajozakerin, 2010). It consists of a microcontroller (ATmega32), a graphical LCD, several sensors of different types; several on/off actuators (relays), and a COM port (RS232), see Fig. 2. The digital sensors are connected directly to the port of the microcontroller whereas the analog sensors are connected to the internal A/D circuit which converts their analog readings to digital. The essential function of the central controller is to read sensor values, send them to the SHEMS, and receive data to turn on/off the actuator from the SHEMS application based on the algorithms and readings on the sensors.

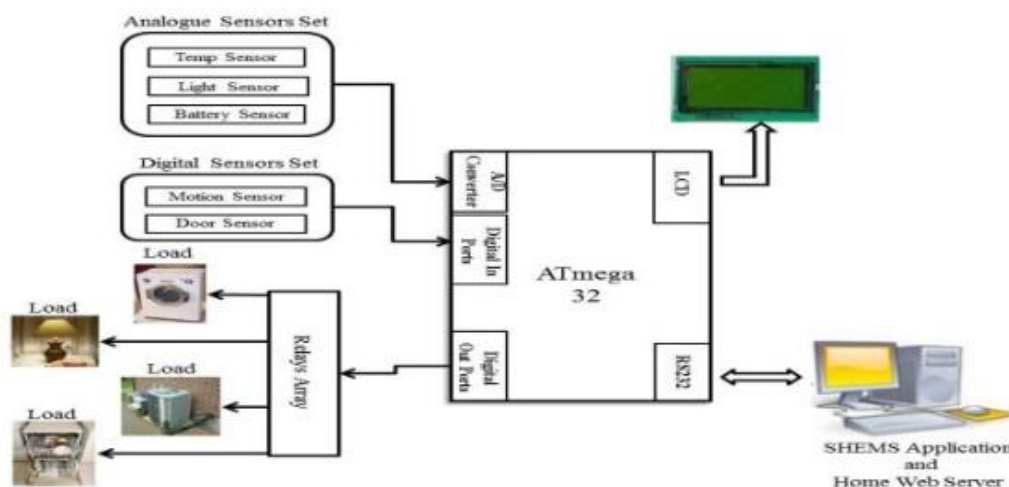


Fig. 2 General Architecture of the Central Controller

The auxiliary controller: It consists of a microcontroller (ATmega32), a graphical LCD, a keypad, and a COM port (RS232) to construct the auxiliary controller as shown in Fig. 3. The main goal of the auxiliary controller is to give authority to the homeowner to enter the home by pressing password via the keypad on the controller when the security is enabled in the home.

application system, a website running on the home-based web server, a SQL Server based database, and an SMS server. SHEMS application collects information from sensors and turns on/off home appliances based on proposed algorithms. SQL Server is necessary to build several tables for the SHEMS system, each one for a specific purpose.

2.3 Software subsystem

The proposed SHEMS software subsystem architecture is illustrated in Fig. 4. It consists of an

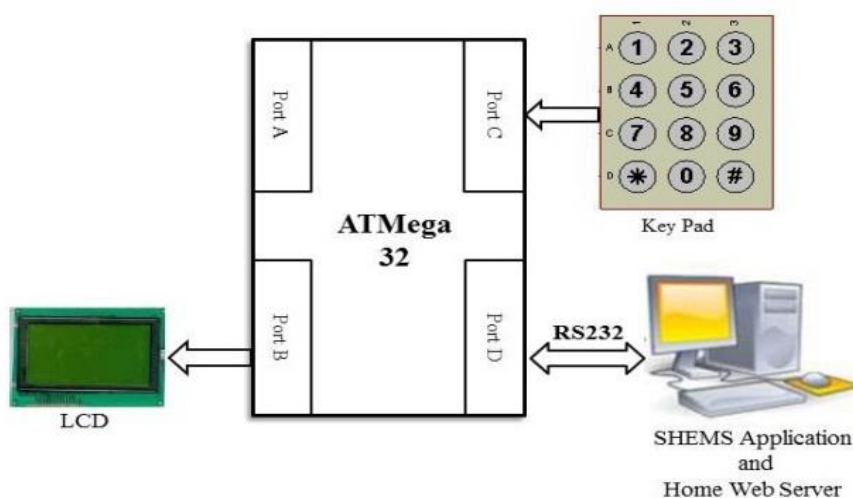


Fig. 3 General Architecture of the Auxiliary Controller

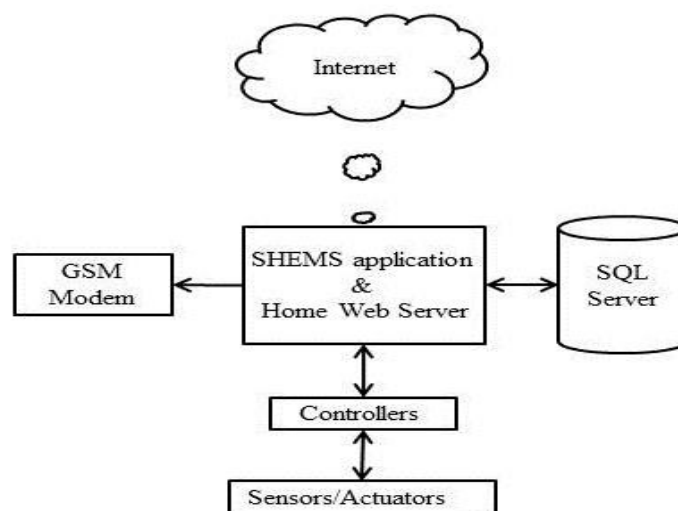


Fig. 4 Proposed SHEMS Software Architecture

2.4 Home Appliances connection

The home appliances are grouped into two categories based on power consumption. High power consumption appliances like air conditioners and low power consumption appliances like light bulbs. They are also classified into three categories based on how frequently they are used; continuous, frequent, or occasional. The first group is continuously used throughout the day; they need the power to always be on, like a refrigerator. The second group is used frequently throughout the day like TV and PC. The last group is used occasionally like a hair dryer. A consumer shows concern about the power usage that is frequently used, see Table 1.

Table 1. Appliances category based on usage

Type of use	Appliance
Continuous	Refrigerator, telephone, water purifier, etc.
Frequent	TV, Personal Computer, washing machine, cooker, light, dishwasher, air conditioner, fan, etc.
Occasional	Microwave Oven, electric oven, hair dryer, video game console, etc.

The automation of home appliances will be applied to frequently used groups. Low-power consumption appliances are connected to solar cell power and home electric power supply via relays which exchange between them based on the state of the charge of the solar cell battery which is monitored by a charge sensor. High-power consumption appliances connect to a home electric power supply only.

3 SHEMS SCENARIO

Three modes are applied in SHEMS which depend on several factors according to the power management, the inhabitant's existence, and the inhabitant's desire to control the home appliances.

3.1 Computer-based mode

This mode is applied when the motion sensors detect movements in the rooms of the home. The

information about the home environment is taken directly from sensors and then sent serially via RS232 to the home server. The information which is collected from the sensor is stored in database tables. Database tables are updated with every reading of the sensors set. The decision is taken based on developing algorithms.

3.2 Leaving mode

This mode is applied when the inhabitants leave home and motion sensors detect there is no one in the home and the door sensor is closed. When leaving mode is activated, home appliances will be turned off and the internet enables the remote control. The homeowner may be interested to turn on the air conditioner to make the home at a suitable temperature. In this mode also, if someone tries to enter the home without entering the password via the keypad of the auxiliary controller, the home server remains on leave mode, and an alarm message is sent to the homeowner.

3.3 Manual mode

In this mode, home appliances can be controlled by the homeowner regardless of the sensor's value and algorithms as an option to make it more comfortable. In addition, the homeowner can take voluntary actions to reduce home consumption by turning off appliances, lights, etc.

4 IMPLEMENTATION OF SHEMS

The SHEMS programs are implemented by applying the proposed algorithms and modes that were explained. These are achieved by using Visual Basic, ASP. Net Web Site and SQL Server Management Studio. The central and auxiliary controllers are both simulated using the Proteus Software ISIS.

4.1 Central controller

The central controller is composed of five parts and simulated using Proteus ISIS, see Fig. 5. These parts are the microcontroller (ATmega32), sensors attached to port A, relays attached to port B, LCD attached to port C and COM port attached to port D.

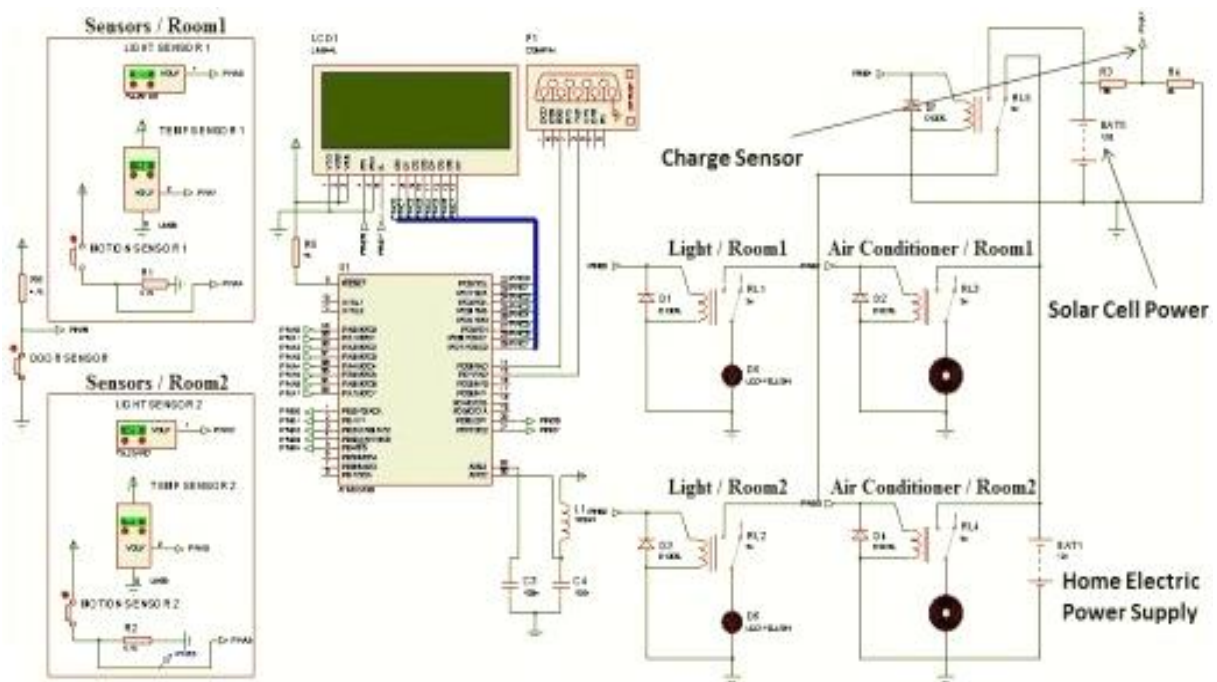


Fig. 5 Simulation of the Central Controller Circuit

4.2 Auxiliary controller

As shown in Fig. 6, the auxiliary controller is composed of four parts. These parts are tested and simulated by using Proteus ISIS. These parts

are the microcontroller ATmega32, Keypad which is attached to port C, LCD which is attached to port A and COM port which is attached to port B.

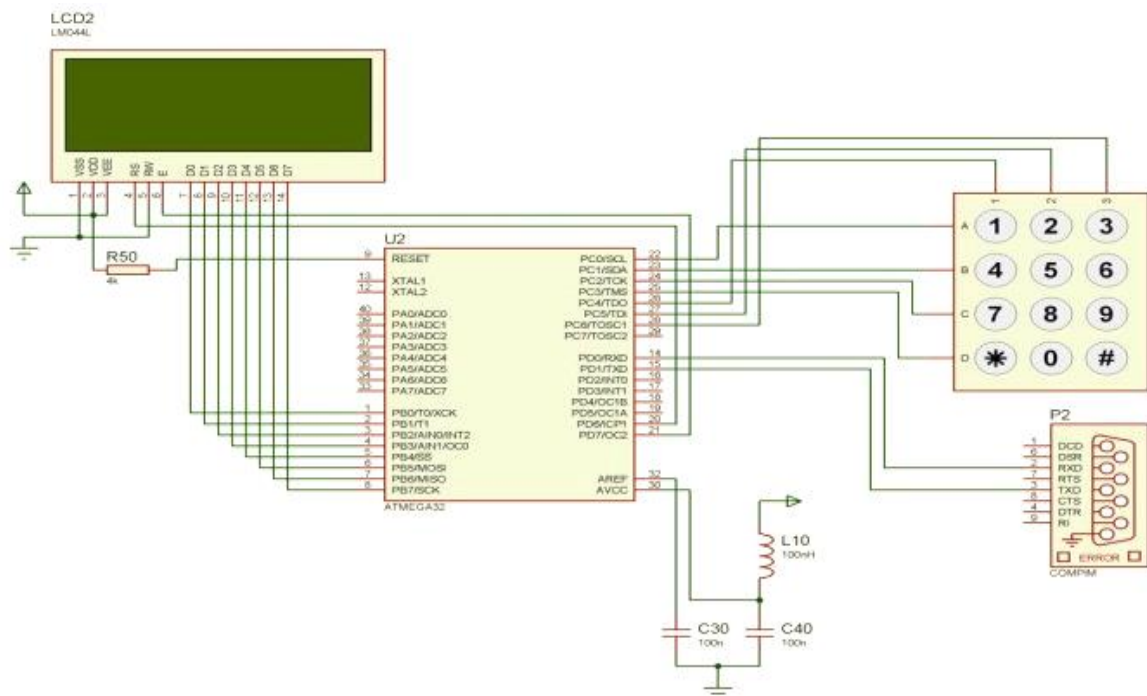


Fig. 6 Simulation of the Auxiliary Controller Circuit

5 SHEMS SIMULATION RESULTS

The SHEMS application monitors and controls the central and auxiliary controllers and manages the database and SMS server.

5.1 Main form of SHEMS

The main form of the SHEMS application has buttons to control and view information about the system. A panel in the main form is the control panel used to connect with the central controller, see Fig. 7.



Fig. 7 Main Form of SHEMS Application

5.2 Room setting form

The SHEMS application in this work is designed for a house with two rooms with two home appliances in each (air conditioner and light). Therefore, a room setting form controls home appliances in two rooms. The room setting form

represents manual mode. Each device has the following three states: (i) ON used to turn on the device regardless of home environment; (ii) OFF used to turn off the device regardless of home environment; (iii) AUTO the device turns on/off based on data received by sensors, see Fig. 8.



Fig. 8 Room Setting Form of SHEMS Application

5.3 System information form

This form displays all information about sensor readings, home appliances state, the solar cell

battery state, the state of charge (charging or discharging), and the total power consumption at that time, see Fig. 9.

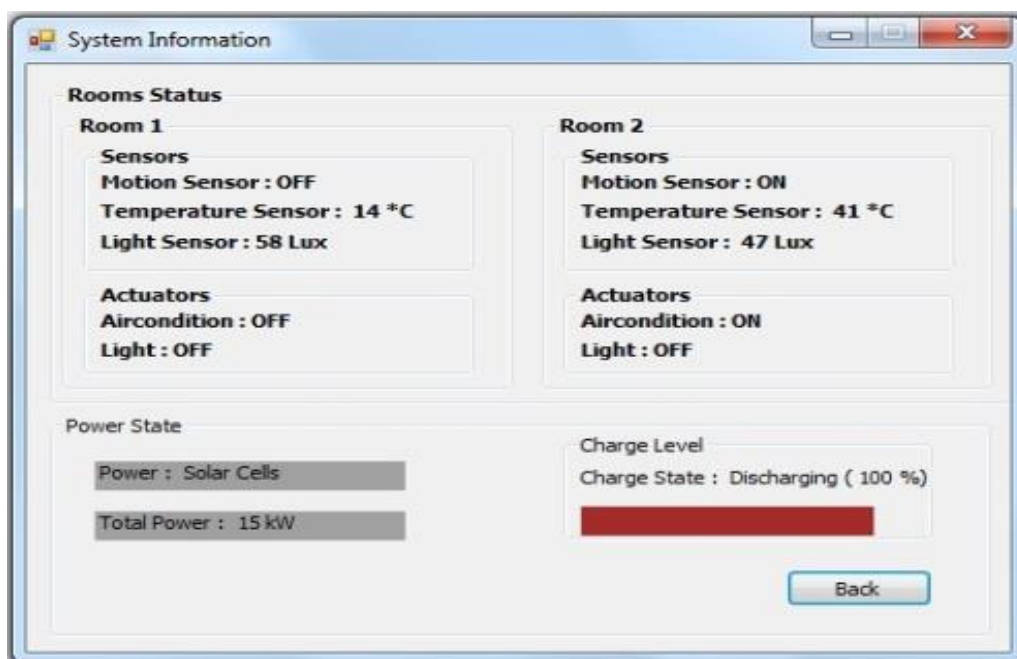


Fig. 9 System Information Form of SHEMS Application

5.4 SMS server form

This form is responsible for sending an alarm SMS message when someone attempts to enter the home without inputting the password of the auxiliary controller. This is done by entering the

phone number that will receive an SMS message. The serial port must be selected to connect to the modem, and finally, the connect button must be clicked. A further option is to specify the number of SMS messages that can be sent during security system penetration, see Fig. 10.

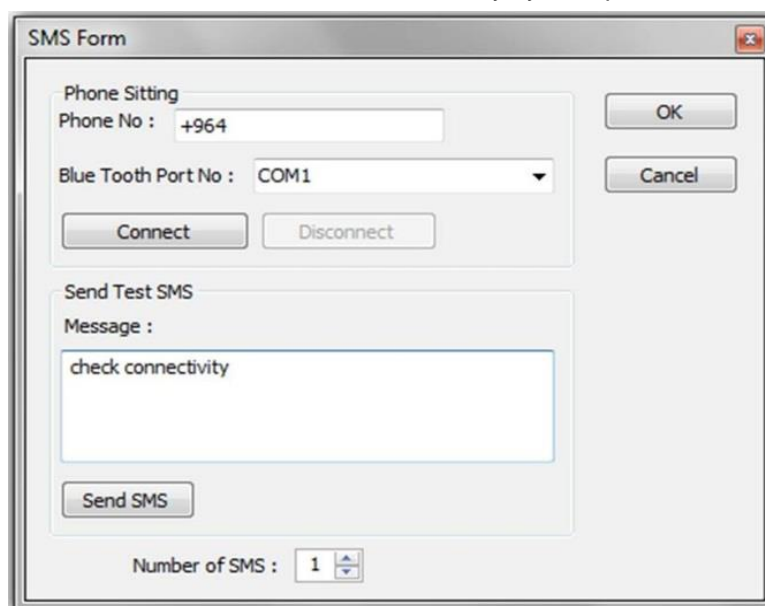


Fig. 10 SMS Server Form of SHEMS Application

6 SMART HOME CONTROL WEB PAGE

The SHEMS system collects useful data from sensors about the home environment and stores them in a database that can be used by the Smart Home Control Web page. The website is designed to allow the homeowner to see the home status and to be able to control home appliances remotely.

6.1 Home Page

The homeowner must have a username and password to enter the home page of the smart home control web page, see Fig. 11. The home page contains all the necessary information which is updated continuously about sensors, home appliances, and power state, see Fig. 12.

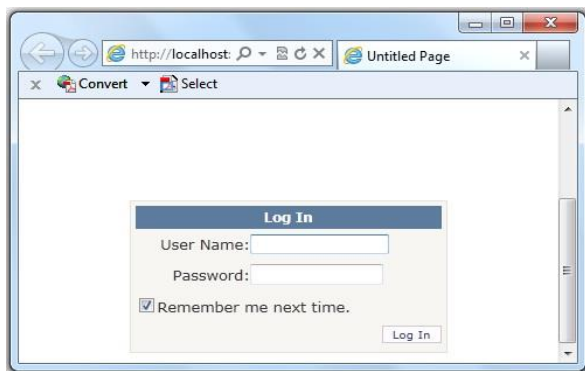


Fig. 11 Login page

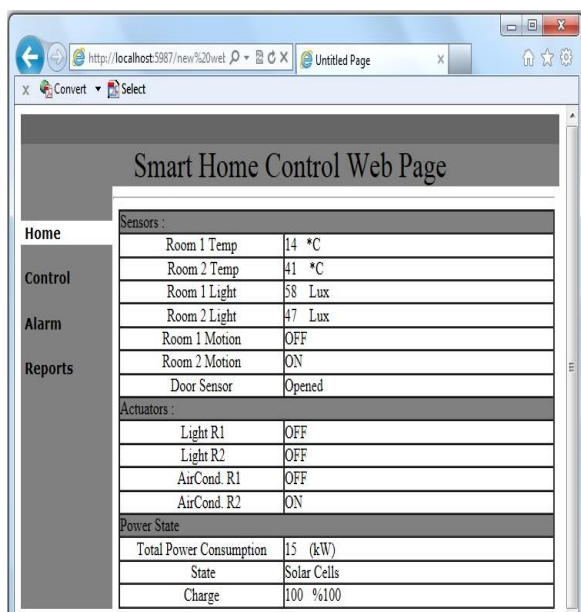


Fig. 12 Home Page of Smart Home Control Web Page

6.2 Control Page

On this page, the homeowner can remotely control

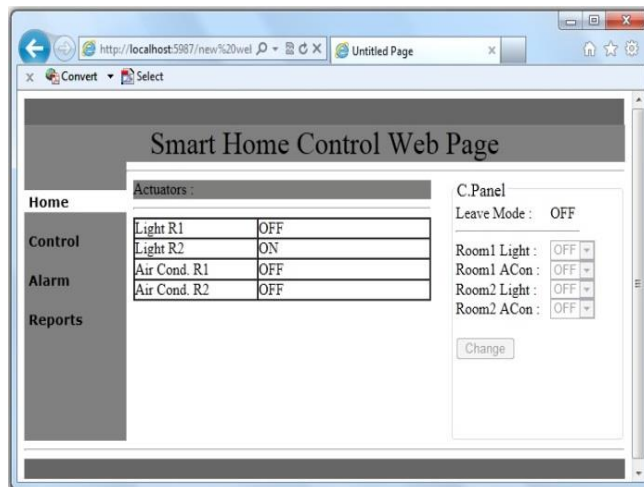


Fig. 13 Control Page of Smart Home Control Web

the home appliances by selecting ON or OFF of specified sensors and then clicking the change button. This is done if the home is in leaving mode else the options of control will be grayed and disabled. Fig. 13 shows the control page of the smart home control web page.

6.3 Alarm Page

This page displays information about home



Fig. 14 Alarm Page of Smart Home Control Web Page

security, whether the home is secured or penetrated in a leave mode state. The alarm message which appears on this page differs according to the sensor detection. This page also loads the date and time, see Fig. 14.

7 CONCLUSIONS

In general, smart homes are becoming promising technologies for the near future and are based on the principle of requiring the least possible human intervention while maintaining the optimum comfort level and minimum energy consumption.

Therefore, after finishing this prototype design of SHEMS and implementing the proposed algorithms using the Proteus Software ISIS, the following conclusions may be drawn:

- The communication between controllers and the PC is fully textual. Therefore, each packet received from the controller is separated by a

“dot” to enable recognition of the value of each sensor and store them in a database.

- To make a compromise between the priorities of the inhabitants in terms of comfort and energy management, requires the creation of three modes in SHEMS. These are computer-based mode, manual mode, and leaving mode.

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FOOD SECURITY ISSUES IN COVID-19 PANDEMIC AND ITS PARTICULARITIES IN GEORGIA

Tamila Arnanian-Kepuladze

Akaki Tsereteli State University, Kutaisi, Georgia
<https://orcid.org/0000-0001-8911-7173>

Giorgi Kepuladze

University of Business and Technology, Tbilisi, Georgia
<https://orcid.org/0000-0003-4642-7811>

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Abstract

Insurance stable food security was and remains, one of the most significant issues faced by human society. Food security is an important socioeconomic and political issue at the individual, national, and global levels. In the conditions of global cataclysms like the COVID-19 pandemic, the problem of food security becomes even more difficult. As mentioned at the opening of the Joint Technical Symposium held on December 16th, 2022, "There is no certainty when the next pandemic will strike us, but there is the absolute certainty that it will happen again". In such conditions, rethinking the gained experience obtained through the COVID-19 pandemic becomes particularly important. The article distinguished two aspects of food security – the food quantity problem and the food quality problem and considers the impact of COVID-19 on food security at the levels of countries, human groups, and economic sectors. On the country level, the paper discusses countries that experienced food problems in the past, food-import-dependent countries, and food-export-dependent countries. On the human groups level, the article distinguishes communities and groups of people who already experienced hunger, socially unprotected populations, and the so-called "new poor". On the economic level, the paper defines sectors of the economy that were highly affected by the COVID-19 pandemic. It also analyses the food security issues in Georgia and the effects of COVID-19 on the domestic production of main groups of products, the ratio of import and export by groups of products, and the self-sufficiency ratio according to some groups of products.

Keywords: Food, security, COVID-19, Production, Food-Import, Food-Export, Self-sufficiency

Address of the corresponding author:
Tamila Arnanian-Kepuladze
tamila.kepuladze@atsu.edu.ge

1 INTRODUCTION: FOOD SECURITY – A BRIEF LOOK AT THE HISTORY

In international practice, the food security term first appeared in 1972-73. But food issues-related discussions go back to the International Agriculture Conference in Rome held from 28 May

to 7 June 1905 when 40 countries signed a Convention (1923). That way, they established the first intergovernmental agriculture-issue-connected organization - the International Institute of Agriculture.

The International Agriculture Conference in Rome, as well as the signed Convention, was base-idea for the ideas developed by the United Nations Conference on Food and Nutrition held in Hot Springs (Virginia, USA) in May-June 1943 when the delegates from 44 countries decided to establish food- and agriculture-related organization with a purpose to fight a pang of hunger and undernourishment. Their decision was realized on 6 October 1945 in Quebec (Canada) where the Food and Agriculture Organization of the United Nations (FAO) was established. After that, numerous similar organizations were established in and outside the UN system, which at the international or national level together with various international issues, also solve problems related to agriculture.

In 1961 the multilateral World Food Programme (WFP) was established. The Programme was supported by resolutions of the United Nations General Assembly aimed to provide "Food surpluses to food-deficient people through the United Nations system" (UN, 1961, str. 20).

In 1974 the General Assembly of the United Nations adopted the resolution "On global food security commitments" developed by the FAO.

On November 19-21, 2014, the 2nd International Conference on Nutrition adopted Rome Declaration on Nutrition. This Declaration reaffirms the right of everyone to have access to safe, sufficient, and nutritious food. The Declaration acknowledges the importance and multidimensionality of malnutrition leading factors and that all kinds of undernourishment negatively affect the physical and mental development of a person, destroy the immune system, and increase susceptibility to various diseases. The Declaration underlined that malnutrition also has social and economic consequences both for the hungry people themselves and for society as a whole (n.d., 2014, Nov 19, p. 1).

The UN Sustainable Development Summit (New York, September 2015) that joined 93 countries held out promises to end hunger in the nearest 15 years. A little later (from November 30 to 12 December 2015) in Paris the United Nations

Climate Change Conference accepted the Climate Change Agreement and recognized food security as the main direction for future performance.

On December 9-11th 2019, the issues were discussed at a world conference in the capital of the United Arab Emirates, Abu Dhabi. The conference was attended by government officials and food security experts from 135 countries.

2 FOOD SECURITY: THE IMPORTANCE AND MEANING

Food security, as one of the basic socio-political and economic issues, is considered one of the main national and global security elements and a significant indicator of economic development and prosperity. Food security insurance means uninterrupted and timely delivery of all necessary and human health-important food.

Food security issues refer to the physical accessibility of a sufficient quantity of safe food for all social groups. Food security issues are related to national food independence, the ability of the national food system to create conditions for continuous security of food supply to the population, to the sustainability of the national economic system that ensures the stability of population food security.

Scientists consider the problem in the two interrelated and interdependent contexts:

1. *Food Quantity Problem* – means the availability of the necessary amount of food to meet the needs of a growing population of the world and hunger protection.
2. *Food Quality Problem* – means the accessibility to healthy and nutritious foods or food safety for humans and the search for ways to solve it.

Food security is a problem often linked to the continuous growth of the planet Earth's population.

2.1 Food security: Food sufficiency and hunger protection problem

Appropriate data analysis has shown the World population reached its first billion in 1804. That took more than 200,000 years. The population increase to 8 billion took only 219 years (Figure 1).

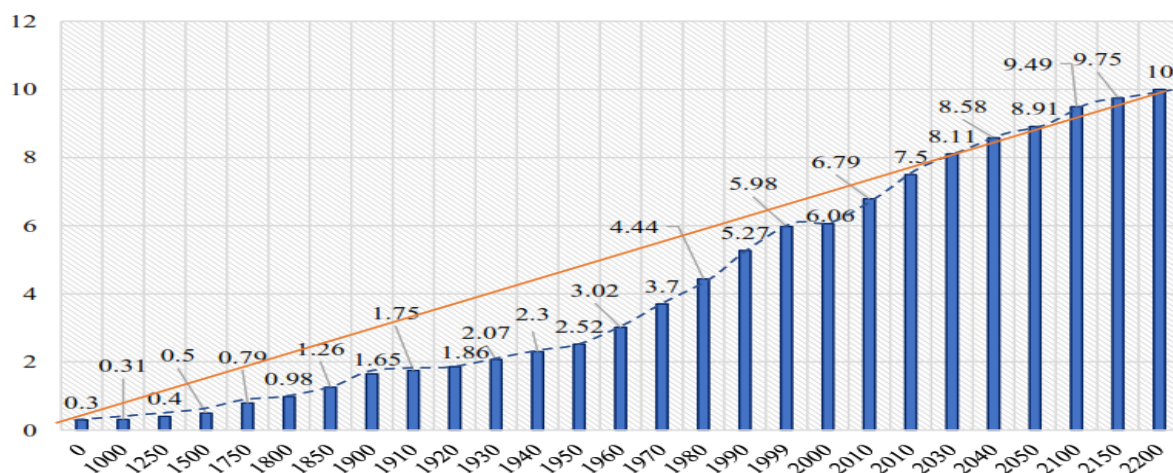


Figure 1: The World population growth (in billions)

Source: Created by authors based on the Worldometer (2023)

On December 15, 2022, there were about 8,005,007,000 people in the World (Worldometer, 2023), and the population is growing by about 65 million a year.

According to FAO data, with population growth, about 820 million people, or about 10.8% of the population, were malnourished or experienced a pang of chronic hunger, or had not eaten enough caloric energy to live normal lives in 2018. That is 0.1% more than in 2016 and 0.2% higher than in 2015 [(Haan, 2006); (FAO, IFAD, UNICEF, WFP, & WHO, 2019); (UN, 2019, p. Part I); (UN, 2019, p. Part II)].

Of those 820 million, 113 million from 53 countries experience severe hunger that directly threatens their lives. Moreover, 143 million people in another 42 countries are very close to acute hunger. That inability to have enough food puts their lives in immediate danger.

Due to malnutrition, 20.5 million children were born underweight, and 1.3 million had health problems in 2018. According to the United Nations Children's Fund, every day closely 22,000 children die of hunger [(UN, 2022) (FAO, IFAD, UNICEF, WFP, & WHO, 2019) (UN, 2019, p. Part I) (UN, 2019, p. Part II)].

Therefore, providing the population with food is one of the most significant issues.

The agency of the United Nations in the field of agriculture, the FAO, whose goal is to overcome hunger worldwide, considers food security as a global phenomenon and distinguishes four main elements of food security, particularly:

- *The availability of food* – means the existence of sufficient quantities of appropriate food quality.
- *Access to food* accession to resources that are necessary and sufficient to ensure a balanced diet.
- *The Rationality of food use*, or in other words, the satisfaction of all physiological needs of the individual through a balanced diet.
- *The Stability of food use* – means eliminating of risk of losing access to food soon.

The problem of food security is directly connected with food quality as well.

2.2 Food security: Food quality assurance issue and protection of health and life

In the face of a relative food shortage, and first, for poor people and countries, the food quality problem becomes increasingly acute.

The assessment of food security in a global context has shown that 7.5% of the world's population, or about 600 million people, fall ill because of eating contaminated food and, according to Disability-Adjusted Life Year (DALY)'s data, 0.07% or 420,000 of them die each year from this cause. (WHO, 2022) Contamination of food products means the presence of pathogenic bacteria, viruses, parasites, or harmful chemical compounds in the composition of these products, which cause more than 200 types of diseases ranging from diarrhea to meningitis and oncological diseases.

The most overall illness caused by contaminated food is diarrhea, which affects about 7.1% of the world's population, or 550 million people each year. It is important to note that 40% of foodborne illness patients are children under the age of five, of whom 125,000 die each year (Haan, 2006).

As Director of the World Health Organization (WHO) Tedros Adhanom Ghebreyesus has mentioned, foodborne illnesses are becoming more and more common, making people's health worse, and many people are dying, endangering the health of future generations and the economies of countries.

Food safety is not only a health problem. It is also a socio-demographic, political, and economic issue.

The existence of accessible and safe foods largely depends on the proper functioning of the national and global economy and their separate sectors agriculture and trade, as well as various policies like poverty alleviation policy, hunger-fighting directed policy, etc. In the conditions of global cataclysms such as the COVID-19 pandemic, the problem of food security becomes even more pronounced.

2.3 The influence of the COVID-19 pandemic on the global economy and population

The global economy faces a new problem today and this problem is the COVID-19 virus that rapidly spreading across the World and attacks the Earth's population.

The pandemic brought and continues to bring huge human losses and essential economic costs. It influences the food system and affects food supply and demand.

Until 20 April 2020, there were 2,350,058 cases of coronavirus worldwide including 161,268 deaths, 7% of all infected, and 606,124 recovered or 26% of all infected. 1,582,666 people were treated. As of 13 August 2021, there were 206,556,420 cases of coronavirus worldwide. By then, 4,353,453, or 2% of all those infected, had died. 185,346,557, or 47% of all those infected, have recovered, and 16,856,410 were being treated (OECD, 2020).

The economic destruction started with the COVID-19 pandemic and produced food crisis risks.

Caused and forced by pandemic quarantines, closure of service enterprises, disruptions of markets, jobs lost, limitations of food and other goods supply chains, restrictions of trade, etc., create economic and humanitarian consequences that could be much heavier than the pandemic itself. It leads to the escalation of the issues of access to substantial food and intensifies food-related problems.

2.4 Food safety under the influence of the COVID-19 pandemic

According to UN warnings, the COVID-19 pandemic could cause a global food shortage. It means that food insecurity remains a global challenge.

What and who are impacted by COVID-19 in respect of food security? We can consider this question with three dimensions:

1. countries level,
 2. human groups level, and
 3. economic sectors level.
1. **On the country level** most impacted by the pandemic are the following countries:
 - a. *Food-issue-experienced countries* or countries that already had substantial problems with food supply before the pandemic spread. The pandemic most impacted those states.
 - b. *Food-import-dependent countries*, or countries that rely heavily on imports of agricultural products and food. All countries to some degree are import-dependent, but poor countries and regions with rapidly growing populations are most likely to be affected by the impact of COVID-19.
 - c. *Food-export-dependent countries* are countries whose economies focus on agricultural products and food production and export.
 2. **On the human groups level**, the most influenced by COVID-19 are vulnerable groups that include:
 - a. Communities and groups of people who, to some degree, already have experienced hunger or other problems with food consumption. These are mostly the poor in both developing and developed countries.

- b. Socially unprotected (so-called vulnerable) segments of the population, such as the aged population (single pensioners and elderly persons), large and single-parent families, people with disabilities, children from vulnerable families, etc.
- c. Groups of people who have not previously experienced problems with food consumption, but they, because of the COVID-19 pandemic, lost their jobs, or had difficulties with their business, etc., lost income and began to experience problems with consumption, including food. Therefore, this category faces the threat of replenishing the ranks of the so-called *new poor* (Armania-Kepuladze, Dali, & Kepuladze, 2021). This category of people mainly includes small farmers, small businesses, individual entrepreneurs, informal workers, employees, or self-employed in some sectors of the economy.

3. **On the economic sectors level**, COVID-19 negatively affects the production and processing of agricultural raw materials, fishery products, aquaculture, the hospitality industry, the restaurant and hotel business,

transport and logistics systems, culture, and education, etc., as well as on the labor-intensive industries such as services, which in poorer countries tend to be less digitalized and therefore more dependent on direct contact.

How has COVID-19 impacted the agricultural sector in Georgia?

2.5 Food security and COVID-19 pandemic: Georgia context

Food security is one of the directions of Georgian socioeconomic and energy security (Law, 2018).

One of the measures of food security is the Food Security Index (FSI) which includes three dimensions:

1. Access to food.
2. Crisis level, and
3. The food system and economic resilience.

According to Deep Knowledge Analytics (DKA), by July 1st, 2022, the Food Security Index for Georgia was 5.53. The Access to Food indicator equaled 5.71. The Crisis Level indicator was 3.68, and Food System and Economic Resilience indicator was 4.57 (DNA, 2022).

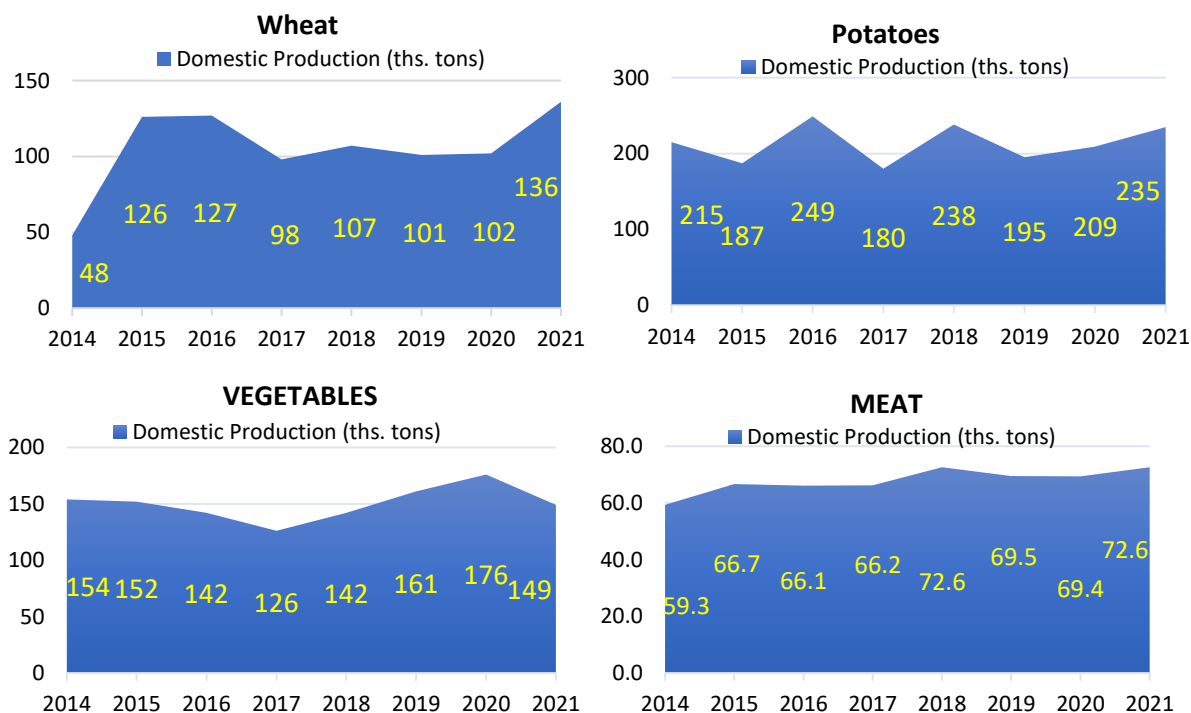


Fig. 2 Part I

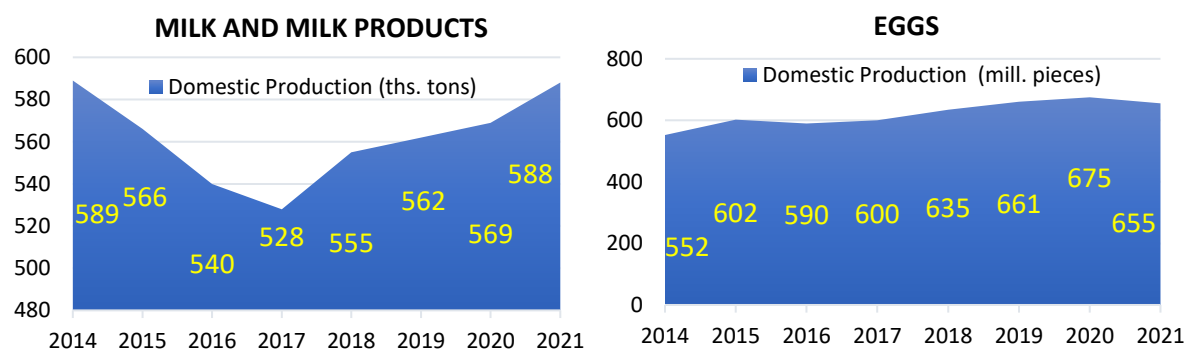


Figure 2: Domestic production in Georgia by groups of products
Source: Created by authors based on the Geostat data (geostat, 2022)

Another indicator of food security is the Self-Sufficiency Ratio (SSR). It represents a percentage of used food covered by own production or the relation between consumed food of domestic production and all consumed food calculated in percentage.

Figure 2 demonstrates the amount of domestic production by main groups of products in the case of Georgia.

As Figure 2 shows, after the appearance of COVID-19, the domestic production of wheat not

only did not decrease but also slightly increased in 2021 and amounted to 136 thousand tons. The same goes for potatoes, meat, milk, and milk products. The production of vegetables decreased from 161 thousand tons in 2019 to 149 thousand tons in 2021. The production of eggs also decreased. In 2021 the production of eggs was 6 million pieces less than in 2019.

Table 1 expresses the Self-sufficiency ratio in Georgia by most significant groups of products.

Table 1: Self-sufficiency ratio (%) in Georgia by groups of products

Year	2014	2015	2016	2017	2018	2019	2020	2021
Wheat	7	17	19	15	14	15	15	22
Corn	91	77	79	64	71	70	68	74
Vegetables	66	66	64	65	60	62	63	61
Potatoes	88	89	90	113	102	93	92	115
Meat	43	48	48	48	52	48	49	51
Milk and Milk Products	90	87	82	82	81	81	81	81
Eggs	96	102	100	98	99	96	97	98

Source: Created by authors based on the Geostat data (geostat, 2022)

For this study, 2019 is considered a milestone year before the COVID-19 pandemic and after the emergence of this pandemic.

Data in Table 1 show that wheat production remained unchanged in 2020 compared to 2019. In 2021 the indicator increased to 7%. The self-sufficiency ratio for wheat, from 2014 to 2021, was characterized by an increase. The self-sufficiency ratio for corn fell to 2% in 2020 compared to 2019, but in 2021 the indicator increased to 6% and reached 74%.

The self-sufficiency ratio for milk and milk products was unchanged in the last four (2018-

2021) years. Despite that, the self-sufficiency ratio for wheat remained to be very low.

The self-sufficiency ratio after 2019 decreased for corn (2%) and potatoes (1%), but for vegetables, meat, and eggs, the self-sufficiency ratio increased by 1% for each of the mentioned product groups.

A relatively favorable situation has developed for potatoes. Even though in 2020, the self-sufficiency ratio decreased by 1%, in 2021, it increased to 22%. The overall picture with the self-sufficiency ratio of potatoes for 2014 to 2021 characterizes stable growth, and in 2021 the

sufficiency ratio of potatoes reached 115%. A fairly high level of self-sufficiency characterizes the production of eggs, milk, and milk products for

which the self-sufficiency ratio was 98% and 81%, respectively.

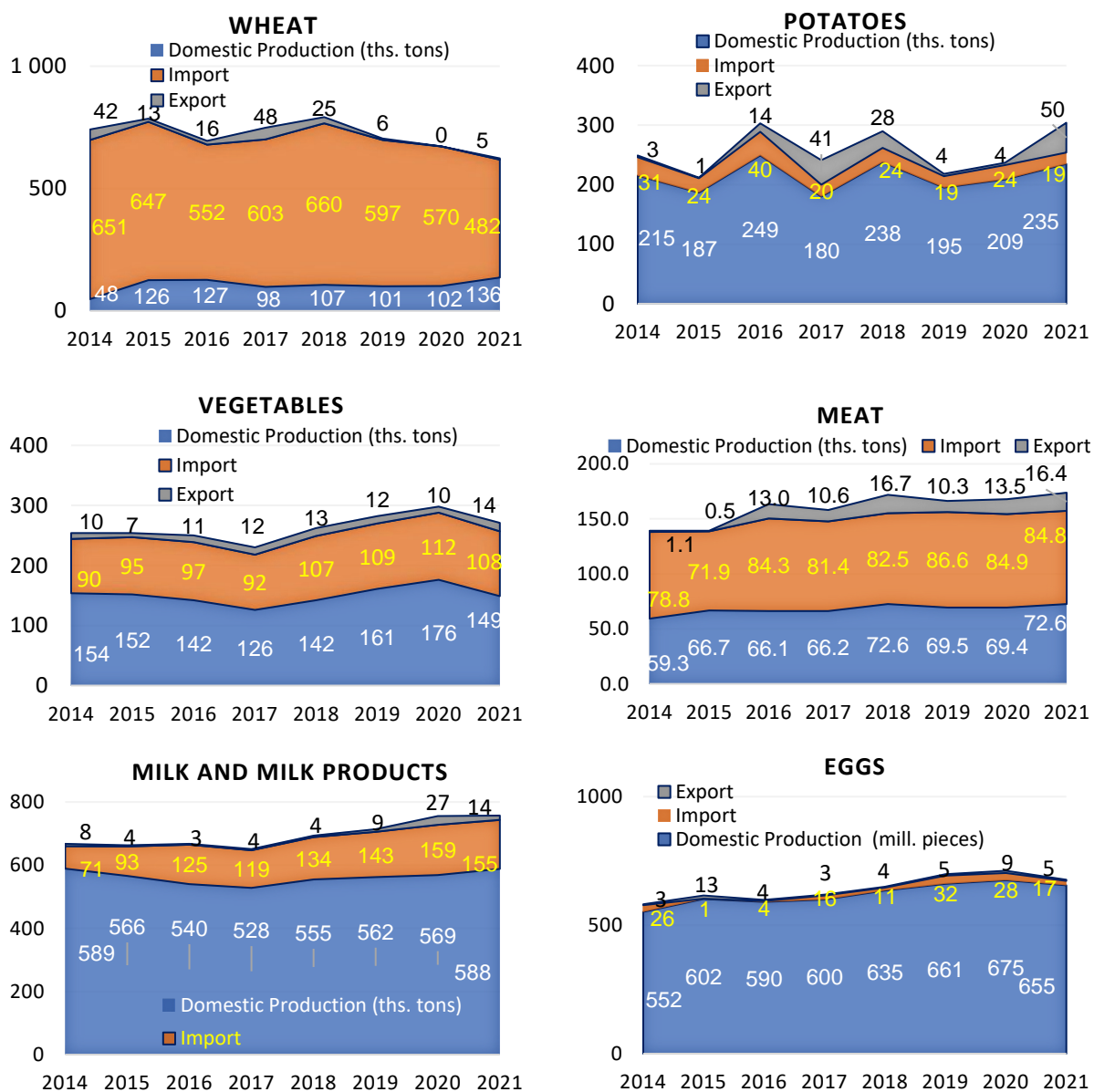


Figure 3: Export-import of main agricultural products
 Source: Created by authors based on the Geostat data (geostat, 2022)

How has the COVID-19 pandemic influenced the export and import of agricultural products in Georgia?

One of the criteria to assess food security is the economic affordability of food.

The economic affordability of food is calculated as the share of expenses for the purchase of

products in the overall structure of household expenditures. In other words, the economic affordability of food is the share of household food expenditure in the total household expenditure.

Figure 4 shows the share of household food expenditure in total consumer expenditure in Georgia for 2007-2021.

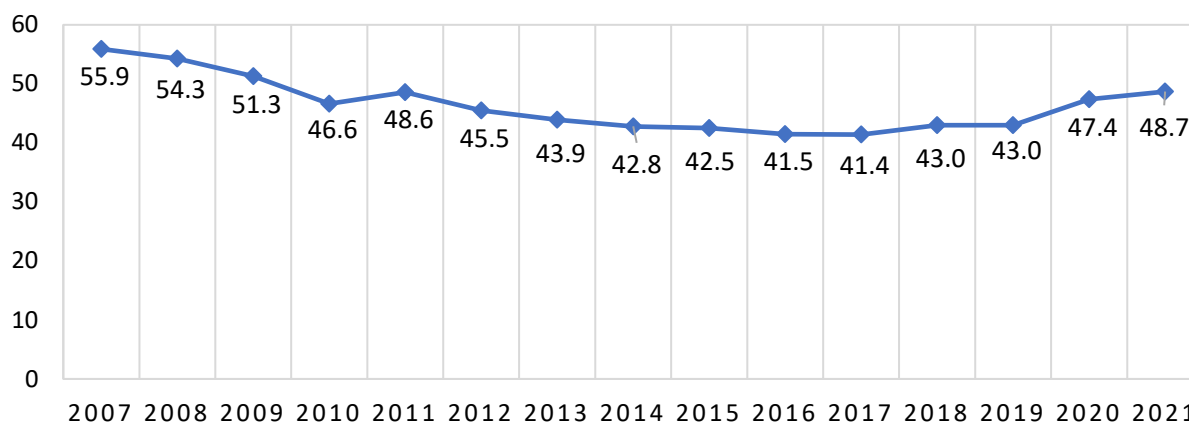


Figure 4: Share of household food expenditure in total expenditure (%)

Source: Created by authors based on the Geostat data (geostat, 2022)

Until 2017, the level of household expenditure on food was steadily declining. But in 2018, this indicator increased by 1.6% and reached 43%. This indicator remained the same in 2019, but in 2020 the share of household food expenditures increased by 4.4%, and in 2021 it increased by another 1.3%.

If the share of food expenditures does not exceed 20% of total final consumption, the food is economically affordable, if a household spends on food more than 20% but less than 33% of its total consumption, the level of food economic affordability can be considered as a medium, while if a household spends on food purchasing more than 33% but less than 50% of its total consumption, the level of food economic affordability can be considered as low, but when a household spends more than 50% of own total consumption on the food, it means that food economic affordability is critically low.

The Georgian population spends more than 40% of its consumption on food. Following the above-mentioned gradation of food economic affordability, Georgia experiences a low level of food economic affordability. In 2021 the share of household food expenditure in total expenditure was 48,7%, and Georgia approached a critical level of food security.

One of the reasons for the low rate of economic affordability of food is the low level of income of the Georgian population. The other reason is the

rising food prices that manifested after 2019. The impulse for rising food prices was an increase in production costs, an increase in the cost of supply chains of raw materials, the need to provide workers with personal protective equipment and disinfectants, etc. The rise in prices in the domestic market in Georgia also occurs because of the influence of food prices in the external market.

3 CONCLUSION

Thus, the spread of the COVID-19 pandemic threatens the stability of the use of food by individuals and groups of people due to the deterioration of the economic activity of some sectors of the economy, which can lead to an aggravation of the problem of food, and subsequently economic, security of some countries and regions.

After 2019 the level of economic affordability of food in Georgia decreased. A drop in the people's real incomes and rising prices in the food market caused that decrease.

Due to the emergence of new strains of coronavirus, food security threats will remain in the future. It requires developing new approaches to the agri-food systems formation and functioning, which should be less susceptible to external factors like social, economic, political, biological, and other circumstances.

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AYN RAND: QUESTIONS AND ANSWERS

Walter E. Block

Harold E. Wirth Eminent Scholar Endowed Chair and Professor of Economics, Loyola University New Orleans, New Orleans, LA, USA

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JEL Category: Z0

Abstract

I pose a series of questions about Ayn Rand and her political-economic philosophy and attempt to respond to them. On most occasions my views are congruent with hers; but not on all of them. Why is it important that the views of this author be scrutinized? That is because, with her novels and non-fiction works, she had a wildly disproportionate effect on world public policy. She did more than pretty much anyone else on the planet to promote private property rights, free enterprise, and laissez-fair capitalism. Her main vehicle, her main contribution to the limited government philosophy was her 1957 book, "Atlas Shrugged" (which is still briskly selling, more than a half-century later). This novel tells the tale of the real contributors to the economy: not workers, but, rather, employers; businessmen, capitalists, inventors, and investors. We all know what happens when employees go on strike: there is vast chaos. This book is certainly the first, and perhaps, still, the only one to trace out what happens when entrepreneurs withdraw their labor. Spoiler alert: it is not pretty.

Keywords: Ayn Rand; objectivism; libertarianism; intellectual property; free enterprise; laissez-faire capitalism; the marketplace.

1. INTRODUCTION

Ayn Rand (1905-1982) was born in Saint Petersburg, Russia, and died in New York City, New York. The author of the still best-selling novel *Atlas Shrugged* (first published in 1957), she profoundly influenced politics and political economy in her adopted country. It is probably no exaggeration to say that she converted more people to the philosophy of libertarianism than any other person,¹ even though she dismissed

advocates of this view as “hippies of the right”² and instead led her group, called Objectivists.

Here are a series of questions and short answers concerning her, her career, her viewpoints, and her accomplishments.

2. QUESTIONS AND ANSWERS

1. Much of Miss Rand’s³ ethical, social, and economic thinking is considered highly reactionary. Why do you think it is still valid among many thinkers?

"Reactionary" means, merely, based on the past. What is wrong with that? Mozart and Bach, my two favorite composers, are reactionary in this sense. Does that mean they were poor musicians?

Address of the author:
Walter E. Block
wblock@loyno.edu

¹ With the possible exception of congressman Ron Paul
² Ayn Rand Lexicon (2022)

³ She insisted upon “Miss” and adamantly rejected “Ms.”

Hardly. Just as Mozart and Bach are “still valid” this applies to the views of Ayn Rand, and other free enterprise philosophers.

In sharp contrast, virtually her polar opposites are now characterized as “progressives.” This linguistic practice only attests to the fact that leftist wokesters have to a great degree taken control of “acceptable” language. I’ll take her supposed invalid reactionary views over those of the “progressive” left liberals any day.

2. What are Rand’s best contributions to philosophical and economic thought?

I am not much of a fan of her contributions to philosophy. One commentator was unkind enough to characterize them as a “knot on the tree of knowledge.”⁴ She called this perspective “Objectivism” and it all started with “A is A.” From that, she deduced all sorts of conclusions, mostly insightful, but the process left something to be desired.

However, regarding her views on economics, there is a very different and far better story. She supported laissez-faire capitalism, the last best hope for the welfare of mankind. She was radical for capitalism, defending it with verve and wisdom.

3. Ayn Rand’s opinions have always been very close to the ideology of Republican politicians. Why? Do you think she has influenced Donald Trump?

Her and their views of economics are not that close, unfortunately for the latter. The Republican party supports things like the minimum wage law, tariffs, and welfare that she properly opposed. Yes, her influence is great and certainly includes Trump at least to some small degree. It cannot be denied that the Republicans are by and large closer to her views than the Democrats, but it is only a matter of (a small) degree, not kind. Yes, there are some honorable exceptions. Senator Rand Paul and Congressman Ron Paul come to mind in this regard. But by and large, the Republicans at best espouse a pale carbon copy of her important economic insights. Well, I

suppose that is better, alright, far better than the Democrats who are for the most part 180 degrees apart from her economic perspectives.

4. Many conservative politicians, including Donald Trump, defend Miss Rand’s ideas. Why? What makes them so appealing?

She wrote and spoke with verve and electricity. Her economic views were those of Adam Smith, Ludwig von Mises, and Henry Hazlitt.⁵ But she could say things that would reverberate with the layman in a way that they could not. Her novel *Atlas Shrugged* was first published in 1957. It is still selling thousands of copies every year.

Would be it were more true that conservative politicians, including Donald Trump, were more aligned with her perspectives than they actually are. If this were but the case, we would now have a far better and more robust economy.

5. Rand was a thinker in permanent contradiction. She was homophobic and at the same time led a very liberal sex life for her time and even by today’s “standards”. How can this contradiction be explained?

I do not see a real contradiction here, at least not compared to many other people, who commit adultery and are also homophobic. Yes, the two views, actions, are contradictory from some points of view, but not all.

As to whether or not she was anti-gay, this is a very contentious issue, and I am not competent to answer it.⁶ Certainly to the degree she embraced libertarianism⁷ she would never have countenanced any law forbidding such practices between consenting adults.

6. Greed was one of her basic thoughts. To what extent has it influenced the capitalism we have lived through in the 1990s and are still living under?

Gordon Gekko, in the movie “Wall Street” opined that “Greed is good.” I think he was channeling her in this. The free enterprise system converts the supposed dross of greed into the benefits of gold,

embracing laissez-faire capitalism and never a disparaging word about homosexuality did I ever hear from her or any of her colleagues.

⁷ This was to a very strong degree despite her explicit rejection of this philosophy.

⁴ Smith (2011), citing Goldberg

⁵ Block (2005, 2018)

⁶ I did overlap with Ayn Rand for several years. She and her for a time chief lieutenant Nathaniel Brandon personally converted me from my previous socialist position to one

and Ayn Rand saw this very clearly. She wrote about it very eloquently.

7. What was Rand's view of the U.S. Corporation?

Ayn Rand (1993) was dead wrong when she wrote that large corporations were "America's most persecuted minority." She started from the correct premise that large firms were the greatest beneficiaries of laissez-faire capitalism,⁸ but then falsely deduced that therefore they ought to be the biggest supporters of this system. This was an error: many large firms benefit not from economic freedom but from protectionism from competition by the government. They full well knew on which side of their bread their butter could be found. The Public Choice School calls this "rent-seeking"⁹ and that is a far more accurate way of looking at the matter. So, no big surprise here; move along, folks, nothing to see here in this phenomenon.

However, although this can only be speculative since Miss Rand was not so unfortunate to live in the modern era, one can be pretty confident that she would have been appalled at the prospect of large-scale corporations going "woke."¹⁰ What occurred at Disney World certainly would have stuck in her craw.¹¹

8. What was her view on intellectual property and the supposed Chinese abrogation of this concept?

Here, Miss Rand's views diverge from those of mine and those of my fellow Austro-libertarians. She (1967) was a staunch supporter of intellectual property rights, such as patents and copyrights,

whereas the correct view, in my opinion, is pretty much the polar opposite.¹² China is indeed accused of riding roughshod over so-called intellectual property rights, but this indictment cannot stand, since there are no such rights.

When I steal your bicycle, you no longer have it. I now have it in my possession; I have stolen it from you. However, suppose you invent the bicycle. I see you riding around on it. I am a good copycat. I create a bike of my own, thanks to your initial idea.¹³ Yes, I "stole" the idea from you, but I did not rob you of your bicycle. You still have it in your possession.

What is the difference between the two? Between the bike and the idea of the bike, the former is scarce. Only one person can own 100% of any bicycle. But the latter is not scarce. Many people may "own" the idea of a bicycle. The entire purpose of private property rights is to determine who is the proper owner of the property. Yes, he who creates the bicycle, or the house or the car, or any other scarce item is the proper owner of it. But many people, conceivably all of us, can own, or think of, ideas such as bicycles, $2+2=4$, water is H_2O , the Pythagorean theorem, mass-energy equivalence $E=mc^2$, etc. Thus, it is impossible to "steal" any of the latter, even though, to be sure, they were all first discovered, or created, by a specific individual. Still, he is not the proper owner of any idea since ideas are not scarce.

The world is a far, far, better place due to the contribution of Ayn Rand. She was not perfect, but which of us mortals is?

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⁸ Friedman (1985) said something similar about the Jews. See also on this Frankel, 1983 and Block, 2004

⁹ For a critique of this phrase, albeit not this concept, see Block (2002)

¹⁰ Doescher (2021); Ramaswamy (2021).

¹¹ Berman and Park (2022).

¹² For a critique, specifically, of Ayn Rand's view of intellectual property, see Sandefur (2007); for a general criticism of this perspective, see

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¹³ I never would have thought of that means of conveyance.

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BLOCKCHAIN TECHNOLOGY AND APPLICATION – SMEs ASPECT

Zoran Cekerevac

MESTE, Belgrade, Serbia

<https://orcid.org/0000-0003-2972-2472>

Petar Cekerevac

Independent researcher, Belgrade, Serbia

<https://orcid.org/0000-0001-6100-5938>

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Abstract

This review article is designed for SME owners and directors to understand better what blockchains are and how they work and to support them to start an entirely new blockchain or fork an existing one and create a new token. The article presents technology bases and how blockchains can serve SMEs and foreseeable challenges that could jeopardize the achieved results. Particular attention the authors paid to blockchain applications, transaction cost reduction, and sensitive business information security. Even more attention the authors gave to the challenges connected with digital infrastructures and business practices, investments, lack of interoperability, lack of skills, and legal aspects. Chapter four discusses the creation of blockchains for SMEs from the aspects of choosing a type of blockchain, choosing of consensus mechanism, a platform selection, nodes design, operating systems, instances design, application programming interfaces, and user interfaces, and the blockchain finalizing. In chapter five, Conclusions, the authors draw conclusions based on the work presented in the article.

Keywords: *blockchain, hash, non-fungible token, IIoT, artificial intelligence, distributed ledger technology, operating system*

1 INTRODUCTION

Thanks to cryptocurrencies, blockchain technology has recently become the focus of interest of both scientists and the public. (Cekerevac & Cekerevac, 2022) Although many authors have published their articles about blockchains in the last 30 years, most of the public, even scientists, are not familiar with blockchains. That would not be significant if the founders and

directors of SMEs were not in that group. Ignorance of blockchain technology at this moment can be an aggravating factor in the development of SMEs.

For ease of understanding, one can look at blockchain as a computer operating system suitable to run different business applications, but more professionally speaking, blockchain is a *distributed ledger that facilitates the process of recording transactions and tracking assets in the business network SMEs and their connection to the Internet* (Gupta, 2017). By the term blockchain, we will understand a distributed

Address of the corresponding author:

Zoran Čekerevac

[✉ zoran@cekerevac.eu](mailto:zoran@cekerevac.eu)



database shared among the nodes of a computer network. The main difference between a classic database and a blockchain is how data is structured. The databases collect data and keep them in tables, but blockchains collect information in blocks. (Cekerevac & Cekerevac, 2022) Blockchain is the secure decentralized database technology that allows each node on the network receives valid information about a transaction, confirm it, update, and register it. The most popular record of the blockchain, de facto, becomes the official record. It is worth adding that blockchain technology does not have a centralized server but distributes the data to all nodes.

Due to the characteristics of blockchain technology, products based on it can become widely used tools to ensure the protection of sensitive data, but also to increase trust between business parties. Medium and small businesses and entrepreneurs are most interested in blockchain-based applications outside the financial services sector, especially in sectors such as healthcare, business services, logistics, and retail. In these areas, SMEs can participate as participants in the chain and as service providers in the creation and chain maintenance. If we ignore cryptocurrencies, which are not the subject of this paper, at the time of writing, most SME and blockchain projects were still in the early stages of development or before commercialization. Although the potential is high, no application based on distributed ledger technology (DLT)¹ has been widespread until now.

Blockchain technologies provide SMEs with opportunities to reduce information asymmetries and transaction costs and can help them overcome the challenges of scaling, opacity, and lack of business history, making it easier for them to trade and access finance. SMEs and startups can also benefit from blockchain due to greater efficiency and quality of products and services, improved supply chain management, and innovation in business models. The precondition for all this is the existence of appropriate digital infrastructure. It is expected that the growth of the Internet-of-things (IoT) will accelerate the implementation of blockchains.

¹ For simplicity, the *DLT* and *blockchain* we use interchangeably, although blockchain is a sub-set of the DLTs.

However, the development of an application of blockchain technology does not depend exclusively on SMEs and companies in general. In addition to the insufficient readiness of SMEs to adopt new technology, there are a lack of interoperability in different systems, limited access to high-speed digital infrastructure, and uncertainty about legal responsibilities. Regulatory attention first focused on digital assets and then on the DLTs used in production and services. The governments have recently begun considering ways to promote the industrial application of DLTs. Several governments have started to design their national blockchain strategies. (OECD, 2021)

2 BLOCKCHAIN TECHNOLOGY

If we simplify what we wrote in chapter 1, a blockchain is a database replicated over a peer-to-peer network. One notable feature of the blockchain is consensus.

Multiple parties, network nodes, can continuously reach their consensus on the new blocks of information creation and then add them to the data chain. The data entered in the chain are immutable. That means that they cannot be altered but can be added. That ensures the integrity of the chain. The newly updated chain is stored in all nodes on the network. The consensus finding begins with adding the next block of information. People often call it a distributed digital ledger because they can use it to store any information (including transactions and values) in an unalterable public record distributed among all nodes. The DLTs' key technical components programmers developed in cryptographic research over the past decades. (OECD, 2021)

The principles of blockchain work are explained in literature many times. One good source is the book *Blockchain for dummies* (Gupta, 2017). For SMEs managers it is appropriate to explain blockchains on the example of Bitcoin:

Step 1 – Transaction data.

Each block in the Bitcoin blockchain contains approximately 1MB of data. That blockchain consisted of 417.59 GB of data on July 21, 2022.

(YCharts, 2022) Twelve years before, in April 2010, the blockchain contained 0.01GB of data (Best, 2022).

Step 2 – Changing the blocks.

When the first block was closed, it received a unique signature. Any future change causes the creation of a new block that will include that signature and create a new one, and so on, as shown in figure 1.

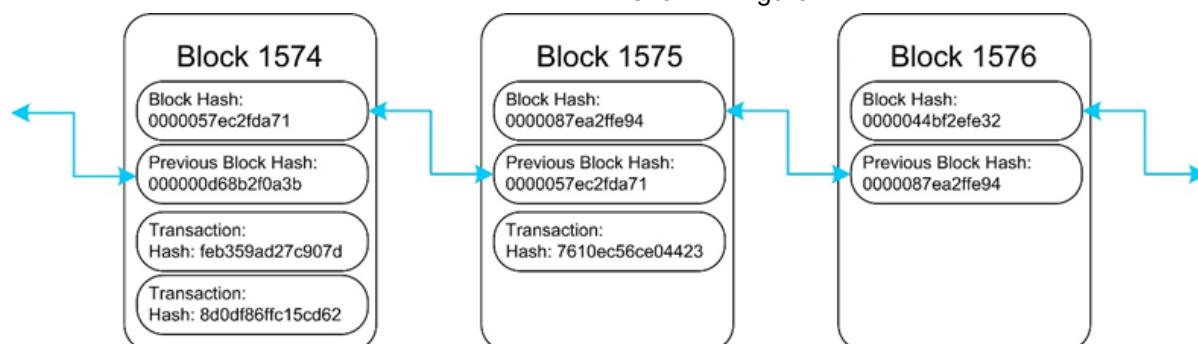


Fig. 1 Blockchain stores transaction records in a series of connected blocks

Source: (Gupta, 2017)

Step 3 – Creating the signature (hash).

In the blockchain, this signature is created by a cryptographic hash function, a very complex formula that any input string transforms into a unique 64-digit string. Only hashes (signatures) that meet requirements are accepted on the blockchain. (Jimi, 2018)

Step 4 – Signing a block and signature qualifying.

The block will be accepted on the blockchain only if its digital signature meets the set conditions. For example, only blocks with a signature that starts with at least ten consecutive zeros are eligible to be added to the blockchain. Each data string has only one unique hash associated with it. What happens if the signature (hash) of the block does not start with ten zeros? To find a signature that meets the requirements the trial-and-error method is applied to change the block data until that specific data string leads to a signature that starts with five zeros. Since transaction data and metadata (block number, timestamp, etc.) must remain unchanged, a small random number is added to each block. That number has no purpose other than to change to find the appropriate signature. That data is called the nonce block. (This is what the Bitcoin miners do.)

Step 5 —Make the blockchain immutable.

Each block change will separate it from the following blocks. If someone tries to falsify a block, he needs to change it and tie it to the next block again. That requires every block that comes after it gets a new signature that should also meet the

set conditions! Giving new signatures to all these blocks is very expensive and time-consuming, although at first glance it does not seem impossible. What makes that action impossible is that also the rest of the network calculates new signatures for new blocks. So, a corrupt miner would have to calculate new signatures for all blocks added up to the end of the chain. To achieve this and catch up with the latest transactions, a malicious miner must have far more computing power than the rest of the network. Otherwise, it will never catch up with the rest of the network in finding signatures. In the past, when the blockchain was much shorter such attacks (called a 51% attack) were possible, but now it is completely unprofitable.

Step 6 - Blockchain management.

Blockchain follows a democratic model of governance. It updates its transaction log according to what most users say is true. It does this automatically by always following the record of the longest blockchain it has because it assumes that this chain represents the majority. That is, at the same time, how the modified block is automatically rejected by most of the network because it is not tied to the longest chain. The transaction history is public on the blockchain. Anyone can look for any wallet or transaction that ever happened from the very first transaction.

Step 7 - Where are the cryptocurrencies here?

Cryptocurrencies are a modified form of bitcoin. Most cryptocurrencies are built on their blockchain protocol. They are essentially money; however,

they can be assigned another function depending on their issuer. They can be called *tokens*. These tokens can give owners the right to *something*, i.e., any type of value can be associated with a *cryptocurrency* token. Blockchains are not limited to the registration of tangible assets. They have the potential to securely register data in the form of medical records, identities, historical records, tax records, etc.

To summarize, because the DLTs distribute data among the nodes of a network and each of them stores the complete history of transactions such databases are secure without requiring that any participant in the network trusts another. In addition to security, the distributed nature of the blockchain significantly reduces the problem of single-point errors and failures because multiple nodes retain identical data. Transactions can range from simple (e.g., property rights transfer) to complex (e.g., smart contracts² with automatic transfer of digital assets upon agreed terms meeting).

3 CREATING A BLOCKCHAIN

3.1 Choosing the blockchain type

The different blockchain protocols and architectures can be adopted when developing a blockchain-based application, but the decision about the blockchain type is also significant. The designer can choose between two groups:

- the public blockchains, or
- the private blockchains.

The first group corresponds to the principle that every user has the right to read and write without special permission. The records verification would be according to the consensus protocol, as with Bitcoin, Ethereum, etc. A subvariant would be read-only, where everyone has the right to read the record, and only authorized users can add blocks to the chain, as in the case of Sovrin³ and European Blockchain Services Infrastructure⁴.

The private blockchains can be organized as a consortium or an enterprise. In the consortium blockchain, only consortium partners can read and

write data. Some examples are Hyperledger Fabric and Quorum. The enterprise blockchain forms at the enterprise level, and the central administrator grants read and write permissions.

In addition to these basic groups, depending on the needs, also hybrid solutions can be formed, which increases the number of potentially different groups.

The SMEs can either create their private or join the blockchain of their larger partners.

3.2 Choosing of consensus mechanism

After choosing the blockchain type, the company should choose a consensus mechanism by its needs. There are different consensus mechanisms, and it is crucial to choose the one that will be optimal for the needs of the goal of a particular company. The most popular is Proof-of-Work (PoW) mechanism, but it is not ideal for SMEs because it is a huge energy consumer and requires powerful hardware. The blockchain creator must study the other DLT systems (e.g., Hyperledger, Quorum, Corda...) and consensus mechanisms (Proof-of-stakeholder, Proof of Elapsed Time, Byzantine fault-tolerant, Federated Consensus...) to determine which will best suit the set project task.

3.3 Platform selection

It is not to expect SMEs to develop a platform for their specific needs on which they will implement their blockchain. It is best to choose one of the existing ones. Choosing is not easy because each platform has its specifics and offers something that others do not (still). It is certain that over time and through further development, they will be more unified, but this is not the case now. That is why SMEs need to find a platform that will suit their needs and available budget. The offer is excellent. A website *101 Blockchains* (2020) recommends Corda, Ethereum, Hyperledger Fabric, Hyperledger Sawtooth Lake, Hyperledger Iroha, Quorum, Stellar, OpenChain, BigChainDB, and others. For businesses, it especially recommends

² Stored on blockchain ledgers (e.g., Ethereum), smart contracts between two or more parties are simply programs stating reciprocal obligations that run when predetermined conditions are met.

³ See (Sovrin, 2022)

⁴ See (EC, 2022)

Hyperledger Fabric 2.0 and Hyperledger Fabric Use Cases and Case Studies.

3.4 Nodes design

After choosing the consensus mechanism and platform, it is necessary to design the nodes. An important decision is whether the nodes will be in the cloud or the company locally. Hybrid solutions are also possible, a part in the cloud and the rest in the company. It is necessary to define the minimum hardware requirements for the in-the-company-located part. The solution is influenced by the chosen blockchain type and the consensus mechanism.

3.5 Operating systems

After selecting the hardware, the SME must decide on the choice of the operating system in which the nodes will work. Free OS based on Linux and paid Windows are available, and several specialized blockchain OSs are also.

As with traditional operating systems, blockchain OSs introduce a layer beneath the software to make interfacing with the hardware easier. In this case, the hardware is blockchain. Such OSs offer benefits in security and privacy and deregulated decentralized OS use. They intend to facilitate easier development and a better user experience. The concept is new and emerging, and its real-world use is still limited. But we will see thousands of devices running on such blockchain OSs very soon. Some of the blockchain OSs are (Sharma, 2022):

- *ConsenSys Codefi* – This operating system is a product suite with the modular capability to digitize financial instruments focused on being an easy-to-use tokenization system for finance, such as payment systems, data analytics, and more.
- *EOSIO* – is a multi-purpose platform for decentralized application creation and operation (Dapps). Using the EOSIO, users can create scalable databases on the network and open accounts with low fees, large transaction velocity, minimal risk, and maximum profit. (eosio, 2022)
- *Overledger OS* – is an operating system that enables connecting or interoperating with any

network, and every current and future blockchain, without extra overhead. It is an interoperability platform for bridging multiple blockchains and supports up to 10 popular blockchains, including Hyperledger Fabric, Corda, Ethereum, Bitcoin, EOS, and Ripple. As an enterprise OS, it interconnects blockchain enterprise platforms and networks. (Seq, 2019)

- *LibertyOS* - Creators claim it to be the operating system focused on user privacy, security, speed, stability, and accessibility without ads. It offers vast libraries of software and applications for usage in production, business, gaming, web surfing, and more. LibertyOS is probably the closest to an *operating system* in the way most people think (Bussler, 2022).
- *TRON* – is a decentralized, open-source blockchain-based operating system that comes with smart contract functionality and a cryptocurrency called Tronix (TRX). (Sun, 2022)

There are several blockchain operating systems, but they all are in their nascency. It is expected that there will be years, even decades before they stabilize their position in the market. It is all logical because the classic systems needed decades to be developed and are still under development. However, the adoption of new technologies is accelerating. It is especially true for blockchains whose adoption is faster than IoT and AI⁵.

We witness the growth of the blockchain OSs, and it is likely that moving into 2025, blockchain will incorporate complementary technologies, from IoT to AI and decentralized self-sovereign identity (SSI). (Panetta, 2019)

3.6 Blockchain instance design

Instance creation and management are done based on the chosen platform. Here, SMEs can configure different aspects of the instance, including asset issuance, asset re-issuance, permissions, key management, atomic exchange, native assets, key formats, block signatures, and more. This step is crucial, and SMEs should take the proper time to design the blockchain instance.

⁵ AI – artificial intelligence

3.7 Application Programming Interface and user interface

When the blockchain instance is up and running, it is time to manage the application programming interface (API). Some platforms offer pre-made APIs, but some platforms might not offer them at all. SMEs need them to perform audit-related functions, generate key pairs and addresses, and for data retrieval and storage, data authentication using hashes and digital signatures, and smart contracts.

To be useful, blockchain needs to have appropriate, friendly interfaces for the admin and the users. For the admin interface, blockchain needs to provide as much information as possible but not overwhelm the interface with unnecessary information. For the user, SME can decide to showcase a piece of significant information only. Additionally, if the users are KYC⁶ users in a permissioned network, the blockchain can show them their status with the network, their roles, and other vital information. Programmers can use any of the front-end programming languages out there, i.e., HTML5, CSS, C#, PHP, JavaScript, Java, etc. (101 Blockchains, 2020)

Managing smart assets includes payment, issuance, escrow, exchange, and retirement.

3.8 Blockchain finalizing

Blockchain needs to meet the current and future SMEs' needs. It must be reliable, adaptable to new requirements, and scalable. It is likely that over time business conditions will change together with blockchain requirements. The blockchain must be constantly monitored and maintained to be protected. New elements, such as analytics, cloud, artificial intelligence, and so on, should be added to it.

4 SMEs AND BLOCKCHAIN – OPPORTUNITIES v CHALLENGES

Although blockchain technology is the most frequently used for cryptocurrency transactions, there are no obstacles to using it for other purposes. Storing information on legal contracts, inventory of products and warehouses, transport of goods monitoring, supply management, various

identifications, etc., are activities where SMEs can see their applications. Given the potential of blockchain, now almost everyone who has an entrepreneurial spirit, and understands blockchain, is trying to devise some application of blockchain in society and work. (Cekerevac & Cekerevac, 2022) In this respect, startups play a significant role. Tens of thousands of applications are being developed or under development. The 10,397 cryptocurrencies were active in February 2022. (Statista, 2022), and more than 19,000 in Jun 2022 (Kharpal, 2022). According to the same source, for comparison, in 2013, there were 66 cryptocurrencies.

Now, it is hard to point to a single application based on the DLTs that has already been widely used in business. The reason is the fundamental change in the organization of company data and the cautious approach of stakeholders in the private and public sectors. As stated in a 2019 survey of executives of large companies worldwide, *Implementation* (replacing or adapting existing legacy systems) (30%), *Regulatory issues* (30%), and *Potential Security Threats* (29%) are the main barriers to the adoption of blockchain solutions. Interestingly, these percentages are lower than in 2018 (36%, 39%, and 35%, respectively), pointing to an increased trust in the new technology (Pawczuk, Massey, & Holdowsky, 2019). It comes the time when companies will no longer ask whether to use DLTs, but how to apply blockchain in their business.

If one analyzes the position of SMEs in the blockchain applications area, one can find that, due to limited resources, SMEs are the most vulnerable part of all companies. Blockchain technology can help them overcome ongoing challenges, such as access to finance and intellectual property protection, and cyber-security.

4.1 Opportunities for SMEs' blockchain usage

The nature of startups allows them to explore different applications and create innovative solutions. It is hard for an SME to create an adequate blockchain, but Blockchain-as-a-Service (BaaS) providers have also emerged

⁶ KYC – Know Your Client, or Know Your Customer

offering their platforms. They provide cloud infrastructure and management for companies developing DLTs applications. BaaS providers run the back-end operations of the blockchain system, allowing entrepreneurs and startups to focus on their applications. That way, the SMEs can use the specific features of blockchain technology without massive investments in DLTs development. It is enough to have an idea and to understand this technology. New companies offering blockchain-based services are being encouraged in many countries and various sectors. The cases of Israel and Italy, presented in the (OECD, 2021), can serve as examples.

SMEs in the fast-growing blockchain industry have their chance primarily outside the financial services sector. Startups can develop Proofs-of-Concept (PoCs) blockchain solutions in multiple sectors, such as healthcare, environment, cybersecurity, supply chain management, international trade, digital identity, creative industries, voting, and more. (Cekerevac & Cekerevac, 2022)

The adoption of blockchain applications requires the provision of conditions, capabilities, and incentives. It has been proven that the adoption of digital technologies leads to increased productivity at the enterprise level. However, for a company to adopt internet technologies, it is necessary to have access to the appropriate physical infrastructure (e.g., high-speed internet connection) and to have a quality product, a good management team, adequate organizational capital, and workers with the appropriate skills. Most of the new BaaS platforms possess features that make them particularly viable for applications by SMEs. The BaaS providers manage all the back-end management and offer *ready-to-go* platforms without additional investments.

4.1.1 Transaction cost reduction.

The transaction- and agency costs always follow the classic transactions. For many, reducing costs is a major short-term benefit of adopting blockchain-based systems for businesses. Blockchain technology allows companies to

reduce costs by removing intermediaries and reducing administrative efforts to keep records and reconcile transactions. The additional benefits of the technology are reflected in reduced verification costs and lower networking costs (no need for control by a centralized intermediary). These cost reductions enable efficiencies in, for example, data ownership, privacy, licensing, and monetization of digital content. Non-fungible tokens⁷ (NFTs) can serve as an example of the monetization of digital content.

4.1.2 Sensitive business information security.

Business security has always been relevant, and with the growing importance of information, it is becoming increasingly important. The digital transformation of business and *teleworking* is accelerating this. Blockchain enables the creation of new methods for securing data storage and transmission. The decentralized, untrustworthy, and equitable structure of the network makes these methods inherently resistant to malicious digital attacks. In addition, blockchain technology is characterized by storing time-marked data/transactions in chronological order in distributed networks that are protected from interference and cannot be changed, because the information is stored/published separately in each node of the network. This feature makes the blockchain suitable for a variety of IoT applications for large logistics and transportation systems and business and analytical applications that use machine learning⁸ and advanced AI for data analysis.

There is no doubt that blockchain technology can be used in large supply chains efficiently, but this technology can also increase the operational efficiency of SME supply chains. It can simplify processes and help eliminate errors by making processes more transparent, reducing the number of physical documents, and increasing consistency among information sources. Smart contracts can help optimize order management, deadlines, and delivery and limit delays in debt collection. However, to take full advantage of the

⁷ Non-fungible tokens are digital files based on blockchain. Although the digital files themselves are infinitely repeatable and accessible to anyone, the NFTs that represent them are tracked on their

core blocks and provide customers with proof of ownership of the NFTs.

⁸ Machine learning is a methodology used to train Artificial Intelligence algorithms.

use of blockchain in IoT devices' management, it is necessary to overcome current limitations, such as storage capacity and blockchain scalability. (J.Taylor, Dargahi, Dehghantanha, Parizi, & Choo, 2020)

4.1.3 Automatic contractual obligations enforcement.

Smart contracts can enable SMEs to facilitate contracts with third parties. The use of cryptographic rules and mathematics increases trust in the system's operation. The characteristic of this application is that the contracting parties can agree that after fulfilling a certain condition, the transfer of digital funds will be instantaneous. This *algorithmic enforcement* of the contract is very favorable for the management of SME claims. Such agreements SMEs can apply in the trade but also the protection of intellectual property rights and the issuance of digital certificates of authenticity. (OECD, 2021)

4.2 Challenges for the SMEs' blockchains usage

Like any new technology, a blockchain brings several challenges that could jeopardize the potential benefits. Because blockchain technology relies on the Internet, the precondition of all preconditions is that SMEs have access to high-speed internet.

Further, factors such as regulatory compliance, technical scalability, mistrust among consumers, and acceptance of well-established business practices significantly influence the mass adoption of blockchain technology by small businesses.

4.2.1 Digital infrastructures and digital business practices.

A broadband connection is crucially significant for SMEs to participate in blockchain networks. Research about SMEs' digitalization showed a relationship between digital technology integration into SMEs and their internet connection according to the parameters included in the dimensions *Integration of digital technologies* and *Connection to the Internet* of the IDSME 2018 index. (Bogavac & Cekerevac, 2019) The authors found no strong relationship between the size of SMEs and their connection to the internet. (Bogavac & Čekerevac, 2020) In 2020, more than 90% of SMEs in the OECD economies had access to the Internet, but there remained businesses that were less connected or lacked the adequate speed of connection for effective blockchain adoption. For instance, data showed that access to high-speed connection (at least 100 Mbit/s) for European medium-sized firms has risen from 7% in 2011 to 23% in 2018.

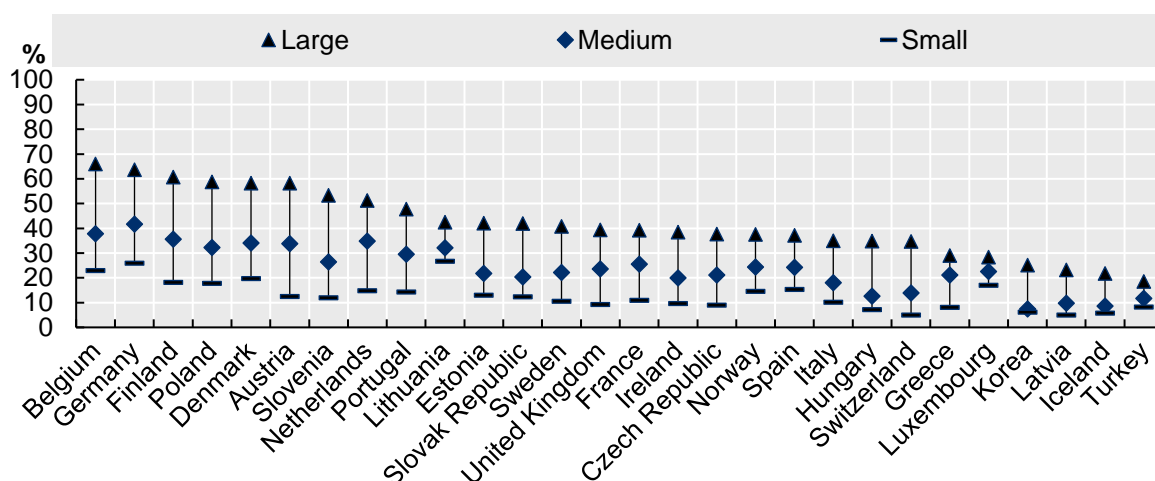


Figure 2. Businesses that share supply chain management (SCM) information with suppliers and customers electronically

Source: (OECD, 2021B)

Even in developed countries like the UK, three out of five SMEs in 2020 did not have access to high-speed internet (Jones, 2020). The gaps between

small and large firms are widening. For example, in Finland, Denmark, and Slovenia, 82%, 86%, and 59% of large firms had access to high-speed

connections in 2018, as compared to 26%, 40%, and 15% of small firms, respectively (OECD, 2019). A complementary digital infrastructure is also required for blockchain adoption in business processes, and SMEs do not always have easy access to them. A noticeable gap exists between large and small businesses in the adoption of systems that enable data sharing digitally. For example, we can consider sharing supply chain management information electronically with suppliers and customers shown in figure 2. The gap amounts to 29% on average across the OECD area and up to 40% in some countries (OECD, 2021B).

The recent introduction of 5G networks will improve the situation with SMEs' access to a high-speed internet network.

4.2.2 Investments.

Blockchain technology implementation requires investments. In the case of supply chains, companies must invest in the industrial Internet of Things (IIoT) and other digital technologies to ensure data quality. Errors are unacceptable because any eventual correction brings increased costs due to the nature of the blockchain. To provide quality data, they need to be correct at the time of generation. To avoid human error and increase data accuracy, it is best to generate and enter data digitally, using IIoT sensors. The IIoT sensors are designed for harsher conditions and safer operation. They are protected from improper and/or malicious use, better than the IoT sensors. Consequently, they are more expensive, which can burden SME accounts. However, the lack of readiness to adopt the IIoT could cause limiting the participation of interested SMEs in supply chains.

4.2.3 Lack of interoperability.

As there is no standard for industrial blockchain networks, and blockchains are being adopted *en masse*, the ecosystem remains fragmented. The current blockchain projects are limited in scope, involve a small group of users, and are usually vertical. The supply chain monitoring applications are often tailored to the manufacturers of final products, so they only track actors who communicate directly and indirectly with the

manufacturer. A similar situation is with projects in the agri-food sector.

The lack of interoperability is not specific only to individual blockchain ecosystems. There have been such situations at a much higher level, e.g., in the case of the EDI standard (Electronic data interchange⁹). Due to differences in premises and authors of individual blockchains, a lack of interoperability occurs. That can be an increased challenge for SMEs. Using Application Program Interfaces (APIs) can support interoperability, but enterprises would still have to rely on intermediary entities to obtain and exchange data between networks. No doubt improved interoperability would facilitate the application of blockchains in SMEs because companies involved in different ecosystems must use several applications now. An aggravating circumstance is that companies that work with one system due to low interoperability between blockchain platforms find it hard to decide to replace the existing platform with a more efficient one.

4.2.4 Lack of skills.

As mentioned in the introductory chapter, the vast majority are unfamiliar with blockchains and what they offer. The transaction costs reduction and increasing accountability can be evident, but it is much harder to build trust among possible users. For example, for an application of a blockchain system, it is necessary to ingrain into business processes all stakeholders, and they all must accept it. In the global level chains, dozens and dozens of entities must participate. Small companies often do not have the capabilities to understand the system and use it. This means that only the larger stakeholders can decide to shift toward blockchain and then include all other participants in their supply chain.

4.2.5 Legal aspects.

Any advantage of blockchain technology can be a disadvantage at some point. The DLTs provide excellent safety and reliability with their security and transparency. However, there can still appear to be fraudulent behavior that could jeopardize intellectual property and sensitive data protection. Due to the characteristics of the blockchain and resistance to unauthorized use, a lack of proper technical knowledge on how to manage the

⁹ See (TX2, 2020)

system (e.g., poor key management) or carelessness can lead to unsolvable problems if something goes wrong. No one knows how many cryptocurrencies remained locked in wallets because the owners lost or forgot the access data. Blockchain relies on decentralized ownership and a network distributed worldwide. That can lead to complications in the event of litigation when it comes to identifying a responsible jurisdiction. Encryption and possible anonymity of users, two key characteristics of the technology, hamper the legal responsibilities identification. That implies blockchain transactions of non-digitalized assets require legal consideration and off-chain settlements, which can be particularly burdensome for SMEs. In the case of smart contracts, algorithmic accountability and the reliability of automated systems pose additional challenges.

5 CONCLUSIONS

Based on the analysis, one can conclude that there is a wide field of possibilities for blockchain technology applications. One of the significant applications is the application in the field of finance and cryptocurrency payments. Due to the small amount of money on the market, it is highly

sensitive to any significant change. Now, it largely depends on banking events, the development of the economy, and the development of the fiat money market. With the increase of the share of cryptocurrencies in the total available money, the market will be more stable.

The possibilities of applying blockchain technology in other areas are much wider. The advantages, such as reducing transaction costs, protecting sensitive information, providing a timeline, and others, enable the successful application of blockchain technology in supply chains, transport, tracking inventory in warehouses, protecting facilities, etc.

It is necessary to provide investments, high-quality digital infrastructure, uniform legislation, trained staff, and standardization of all aspects of blockchain technology to take advantage of the technology benefits.

In the end, we cannot avoid asking whether what blockchain technology provides is possible to do with the systems already in use and whether blockchain technology was needed at all. The answer might be yes, it can be done, but blockchain technology has made things move by searching for better solutions.

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PORT AND RAILWAY CONNECTIONS AND THE HINTERLAND CONCEPT

Selcuk Duranlar

Trakya University, Edirne Vocational School of Social Sciences, Edirne, Turkey

<https://orcid.org/0000-0001-7743-5916>

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Abstract

Intermodal transport began in the early twentieth century with railroad cars loaded onto carrier ships. At that time, only a few systems were available as standard freight units suitable for intermodal transport. By the middle of the twentieth century, the carriage of road vehicles, known as piggybacks, using car carrier ships or flat car trailers, became more common. Considering that that mode of transport will always play a role in the transport of containers, one can conclude that congestion problems in ports burden the infrastructure near the ports also. The deficiency of space forces ports to improve solutions for port tasks such as filling, storage, and congestion, using the new port concepts with the port entrance shifted to the interior. The increasing volume of container transport in ports has also led to a general increase in the transport volume in ports, increased the geographical coverage of the market, and significantly transferred ports into hinterlands. Ports have played a vital role not only in terms of domestic activities and the provision of exports and imports but also in other transport networks. In this study, the author emphasized the importance of hinterland logistics and proposed some solutions.

Keywords: *Hinterland, logistics, port, railway, transportation, management*

1 INTRODUCTION

Road transport remains primarily the most common hinterland transport system in many ports. Road infrastructure is reaching the ports' capacity limits, so heavy traffic jams are frequent in the terminals. The environmental and social impacts of road transport are also the subject of strong debates about the future role of road transport. Many ports also face different constraints in their hinterland and expanding rail capacity.

Address of the author:

Selçuk Duranlar

selcukduranlar@trakya.edu.tr

While before the XIX century, hinterland transport consisted primarily of sailing ships, in the XIX century canal operations became more common by rail.

Hinterland logistics consists of activities that combine the hinterland transportation system and related logistics. Combining large and global maritime networks with hinterland transportation networks is crucial for transportation systems. The expansion of the hinterland also contributes to increasing the port's potential. Close cooperation and coordination between actors in the supply chain and hinterland logistics enable more effective and efficient hinterland systems.

Various scholars have argued that hinterland access is crucial for the competitiveness of seaports. (Langen & Chouly, 2004, p. 362) The authors made a distinction between captive and contestable hinterlands. Captive hinterlands are areas where a port has such a competitive advantage because of low generalized transport costs to those regions and handles most cargoes. For most ports, captive hinterlands are less prevalent. Contestable hinterlands consist of regions with no single port having a clear cost advantage over competing ports. If the vast majority of cargo originates from or destinates for the contestable hinterland, economic rents are small or non-existent. A similar distinction applies to primary hinterlands, the area where the port is well established, and secondary hinterlands, with competition among ports. (Pallis, 2022)

There are great challenges for container ports and terminals to remain competitive and for anticipated growth, increasing their productivity to reduce spatial pressure, thus reducing congestion and improving hinterland accessibility (Nemoto, Browne, Visser, & Castro, 2006).

2 PORTS IN THE EUROPEAN UNION

Although most ports of the two main European transportation networks connect to national rail systems, they are not sufficiently optimized to ensure uninterrupted service. Therefore, more and more countries are implementing and planning construction projects, line dubbing, infrastructure electrification, and signaling system installation to provide a reliable connection that meets their transport demands and the level of integration with the entire transport system and facilitates access.

The European Union has a network of more than 1,400 inland and seaports, with 329 ports and 103 inland ports on TEN-T, of which 104 are main ports. It provides 75% of European trade to the rest of the world and more than a third of intra-European trade. It also provides mobility to 400 million passengers.

Ports are essential gateways for access to international markets as they are part of an extensive global network that enables the mobility of goods. Using links with other modes of transport

shipments reach their destination hubs which deliver goods further to consumers.

In addition to their key role in securing goods, ports are significant economic and energy hubs and currently employ more than 1.78 million European port workers in the EU-28.

In their own right, ports are industrial locations as they encompass power generation, refining activities, port operations at terminals, and securing transport links for mobility, delivery, and cargo picking-up. Therefore, ports form an ecosystem of transport, energy, and industrial systems that contribute to the strategic corridors with added value for the European economy and mobility creation. Ports are also a significant component in achieving the Green Deal goals to create a sustainable society and economy. They are in urban areas. The pollution level in these complex facilities affects residents and the environment in the region.

In their development strategies, EU members should consider projects focusing on multimodal connections between ports, airports, railways, and roads. The new, advanced strategies try to shift traffic to sustainable modes of transport. We expect railway transportation to increase by 50% and inland waterway transportation by 25% by 2030. Therefore, new infrastructure needs to be developed.

Analysis of European Union member states estimates that by 2030 an investment of around 750 billion euros is required to build a core network and make it truly work in terms of performance, speed, connections, and sustainability. Regarding the percentage of project types for port infrastructure, the most relevant is basic infrastructure at 37%, followed by sea access, equipment and superstructure, and infrastructure for smooth transport flows within the port at 8% each.

Ports are much more competitive to serve the same inland areas, and this is especially true for major Western European ports (Le Havre, Antwerp, Rotterdam, and Hamburg), where the distances of these ports from the main freight producing inland areas are not a very distinguishing factor. These conditions provide hinterland accessibility and become increasingly important for a port's competitiveness. The

requirements to be successful are the competitive hinterland transport system, and the ability to provide cost-effective services. The system must be able to serve. The interface between many destinations and port terminals as part of these criteria hinterland modes must be efficient, fast, and reliable. With the development of intermodal hinterland transport (rail and barge), large-scale transport services are gaining importance to shift the cargo route and make the port accessible (Nemoto 2005-17).

Container activities in the port of Rotterdam are spread over the port area, but there are three clusters: Eem/Waalhaven, Botlek, and Maasvlakte. The distance between these clusters is about 40 km. While they are three separate activities, they are highly interconnected. The port should develop activities simultaneously to ensure efficiency (Visser, Konings, Pielage, & Wiegman, 2009).

3 HINTERLAND TRANSPORTATION SYSTEMS AND MODES

The objectives of the hinterland transport system are achieving accessibility and low total cost. The transport system consists of modes, either alone or in combination. Cost-effectiveness and successful logistics highly depend on the probability of a good match with quality and demand. Characteristics of the material flow and design components of the hinterland are crucial. Therefore, it is significant to understand the transportation system characteristics.

Transport modes have different costs. Its main operational features are high speed and limited loading capacity. The existence of intermodal transport depends on combinations.

From the point of view of road infrastructure, fixed costs are high, but from an operational point of view, road transport is characterized by variable prices with a high share. Other important features are high flexibility, usability, and speed but limited loading capacity compared to other modes.

Railroad encompasses high fixed costs and relatively low variable costs. High fixed costs are locomotives, wagons, and transport equipment. Variable expenses are mainly personnel, fuel and maintenance, and repair expenses. Its general operational features are fast and high capacity.

3.1 Hinterland Transportation System Design

Design of a transportation system; It aims to match demand (material flows) with supply through transport. Choosing which mode of transportation(s) to use is based on features such as freight volumes, distance, time constraints, product value, availability of services, etc. (Mangan, Lalwani, & Butcher, 2008, p. 22). The interior transport system design can be defined through its service components.

3.2 Hinterland Logistics - Strategy

When evaluating hinterland logistics design, it is often necessary to choose which one is appropriate. The features related to the services offered by the current logistics service providers are:

- *A large number of users.* The system can benefit from economies of scale as a result of many users. Many users can also contribute to the reliability of the system because it is generally more resilient to changes in the market.
- *Simplicity of application.* The service has been operational since it is very easy to use when starting. There are well-developed routines and shipping times, reliability, security issues, etc.
- *Strategic connection with the providers.* Strategically tied to the provider for a long time, it is free to change logistics service providers connected to a hinterland.
- *Pricing.* Marginal costs of hinterland transport solutions due to economies of scale can be very low
- It is possible to choose whether or not to open the system to other users. This option can be invaluable when it comes to the strategic advantages of the hinterland. The transportation system is so large that it has a significant overall impact.
- Its solution requires long-term commitments and large investments. Their cost is high and there is a significant payback period.
- There are exit opportunities from secondary markets, but they are often associated with significant exit costs. In addition, the investments made, creating human resources for the design, implementation, and

- management of the system significantly influence the payback period.
- When a person manages a hinterland transport system, in many cases there is total control of costs which can be very important such as when the market prices of hinterland services rise significantly or imbalances between supply and demand, if any. When the owner controls the system and costs, he can limit risks of highly fluctuating costs and prices for hinterland transport.
- The system is fully adaptable. A self-managed system depends on schedules, load units, transport techniques, storage facilities, IT systems, etc. provides flexibility.
- *Incentives*; By introducing incentives, the collaborative structure is balanced. Incentives can be, for example, bonuses, penalties, tariff differentiation, guarantees, and capacity and deposit regulations.
- *Formalization*; facilitates communication, trust, and commitment by formalizing cooperation and bringing actors closer together,
- *Creating collective action*. It means the promotion of public governance by the government, port authority, public/private partnership, branch associations, etc., and focus and stability in a context that would be otherwise uncertain and unstable

3.3 Hinterland Logistics - Management

There are only a few studies on coordination and management in hinterland transport. However, the supply chain management literature has long recognized the need to address inter-organizational coordination challenges (Van der Horst & Langen, 2008, p. 109).

We can identify three general arguments about why coordination problems exist. They are:

- *Lack of resources or willingness to invest*. It may be difficult to obtain the necessary financial commitment for collaborations with small companies.
- *Strategic considerations*. Regarding coordination, actors may be reluctant if competitors also benefit from improvements.
- *Risk-averse behavior and short-term focus*. If implementation costs and efforts are high, cooperation is high, and the benefits are uncertain, actors may be reluctant,

These are the factors that must be kept in mind when designing and implementing a hinterland transport system.

After identifying the key factors and common points of coordination problems, it is possible to solve coordination problems in the hinterland transport chain. Managers can apply the set of concepts to deal with the most common coordination problems to identify appropriate solutions to address coordination issues (Vander Horst 2008:110).

Increasing interest in hinterland transport will likely lead to more investment. There will be a general improvement in integration and coordination. However, some ports may cause a decrease in competition due to their competitive advantage in the hinterland. In cases of financial support for the infrastructure provided by national or supranational bodies, the state can enact regulations on port accessibility and provide third parties with access.

4 CONCLUSIONS

Hinterland logistics and transport systems have become a significant and integrated part of global supply chains.

Shippers must focus more on logistics service providers and their simple and efficient design skills. But at the same time, supply chains that are environmentally friendly and of high logistics quality should be the focus. Well-designed hinterland transport systems are not enough alone.

The hinterland transport system is an essential part of the supply chain. When designing an effective and efficient hinterland transportation system, the issue to be considered is the supply chain strategy. Making the right assessments requires unique features and dynamics to understand what hinterland logistics has.

As a logistics service provider, the hinterland is not separate from the ports. It is an integral part of the supply chain. It is part of the network, offering port services.

The logistics service provider must be able to manage both horizontal and vertical coordination with cooperation in the supply chain.

Horizontal coordination takes the form of combinations of single and multiple modes of transport.

Keeping the different actors in the supply chain - shippers, ports, terminals, infrastructure

managers - together is challenging, with its advantages and disadvantages.

As a result, hinterland logistics has become an integral part of globalization. An in-depth understanding and knowledge of supply chains and their management, hinterland logistics, and unique circumstances are crucial for effective design and strategy.

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MACROECONOMIC IMPACT OF THE RUSSIA AND UKRAINE CONFLICT ON THE GROSS DOMESTIC PRODUCT OF SERBIA

Ljubomir Miljkovic

MB University, Faculty of Business and Law, Belgrade, Serbia
<https://orcid.org/0000-0002-3113-1922>

Dragana Trnavac

MB University, Faculty of Business and Law, Belgrade, Serbia
<https://orcid.org/0000-0003-1571-4500>

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Abstract

The conflict between Russia and Ukraine comes at a time when countries worldwide are still recovering from the destabilizing effects of the global COVID-19 pandemic, which has caused deep economic regression, significant loss of productivity, worsening inequality, planetary pressures, and in some cases, security challenges. The economic impact reverberated through multiple channels, including commodity and financial markets, trade, and migration links. At the same time, rising inflation is increasingly reducing the purchasing power of consumers. Such market tensions will reduce economic activity while accelerating inflation with the appearance of stagflation, where a general jump in prices and a decline in production characterize the state of the economy. The direct effects of this conflict lead to macroeconomic instability. This conflict causes a jump in global prices and affects economies worldwide. One can expect that developing markets and countries in the European region, especially the Western Balkan, will bear the brunt. On the side of macroeconomic stability, the effects differ depending on their exposure to the market of Russia and Ukraine. The Republic of Serbia does not have significant, direct trade ties with Ukraine, but the conflict faced Serbia with new challenges, considering Serbia's energy dependence on Russia, as well as the agricultural sector, where products, primarily fruit, have a significant share in total exports to Russia. The crucial question is in which direction the conflict will affect the macroeconomic stability of the Republic of Serbia.

Keywords: Macroeconomics, Economy, Conflict, Russia, Gross Domestic Product

1 INTRODUCTION

Numerous global economic crises of the 20th century made macroeconomic instability with its

impact on GDP a key issue in the analysis of the determinants of economic growth. The multitude of ways in which macroeconomics affects GDP, its various causes, and the range of measurement methods makes economic volatility a complex and multidimensional phenomenon. Understanding the nature and causes of economic progress is the

Address of the corresponding author:

Ljubomir Miljković

miljkovic.ljubomir@yahoo.com

fundamental challenge for economics. We believe that the countries' total number of products and services produced is the best measure of economic progress. An economy is like a machine that transforms inputs into outputs, and the input size determines the size of the outputs. Thus, economic growth responds to changes in macroeconomic policy patterns. Therefore, we conclude that to achieve sustainable economic growth in the long term, macroeconomic stability is necessary.

Macroeconomic instability has stunted growth in many developing economies over the past two decades. As a result, states are looking through the economy for ways to better manage the economic factors that contribute to instability. Encouraging the creation of diverse financial markets, characterized by a wide range of financial institutions, may be one such option for better macroeconomic policy management. Greater institutional diversity could expand the reach of financial markets, thereby reducing liquidity constraints. That diversity can offer some insurance against the effects of boom-and-bust cycles in each type of institution since each type covers only a limited market segment. But greater institutional diversity could contribute to instability. That may be the case especially if states try to encourage institution-building in otherwise underperforming markets through regulatory preferences and subsidies.

Macroeconomic instability has widespread and severe consequences. It tends to reduce long-term economic growth domestically and abroad, as instability can spread to other countries due to trade and capital flows. Macroeconomic instability also negatively affects the poor more than higher-income households because lower-income households have fewer ways to smooth consumption over time due to a lack of access to financial markets, lower savings, and limited coverage.

The conflict in Ukraine has delayed the global response to the COVID-19 pandemic and the recovery of the global economy from it. Before the conflict, the world focused on the health and economic challenges posed by the pandemic: reversing the severe loss of human capital and supporting the global economy amid an uneven recovery characterized by prolonged supply bottlenecks, withdrawal of political support, and

rising inflation, including food and energy. The war has already added an immediate global negative impact, particularly through commodity markets.

The conflict worsens the short-term global economic outlook. It has significant economic spillovers through commodity and financial markets, trade and migration links, and investor and consumer confidence. Because of their direct trade, financial, and migration links with Russia and Ukraine, countries in Eastern Europe are expected to suffer significant economic damage. Several major European economies depend on Russia for natural gas and oil and will also continue to be adversely affected. Although most of the effects have so far been limited to the region, there are also important implications for the global economy.

Significantly higher food and energy prices are contributing to inflationary pressures and leading to expectations of a much faster tightening of monetary policy worldwide. Moreover, since Russia and Ukraine are the biggest exporters of raw materials and are upstream in many global value chains, shortages of these commodities could seriously affect a wide range of industries globally, including food, construction, petrochemicals, and transportation.

The conflict has increased risks to global growth and the likelihood of acute financial stress in emerging markets and developing economies, dampening inflation expectations and widespread food and energy insecurity. A protracted conflict could increase global political uncertainty and cause permanent fragmentation of global financial, trade, and investment networks. Human capital would also be further affected, including in neighboring countries, and many others affected by spikes in food insecurity, especially for vulnerable households. Each of these risks materialization could further degrade the underlying drivers of growth, weighing on long-term growth prospects and increasing poverty and inequality.

2 THE INFLUENCE OF MACROECONOMIC FACTORS ON THE GROSS SOCIAL PRODUCT

To understand macroeconomics, we must first understand economics. The size of a nation's total economy is usually measured by its gross domestic product, or GDP, which is the value of all

final goods and services produced in the country each year. Measuring GDP involves counting the output of millions of different products and services and all other non-financial products and services produced in the current year and summing them up into the total value of a national unit of payment. For all countries, regardless of whether they are developed or developing, one of the main goals of macroeconomic policy is economic stability. With that, monetary and fiscal policy aims to maintain high growth rates in terms of the gross domestic product together with low inflation through price stability.

Numerous factors influence the economic growth and development of the country, and one of the most important is the gross domestic product (GDP). On the other hand, many factors important for the functioning of the economy also affect the gross domestic product. Some of them are market openness, supply and demand for products and services, unequal distribution of income, population, political situation, etc. Natural factors such as climate change, diversification, and sustainable development are also significant for economic growth. The effects of these factors directly affect macroeconomic stability and its impact on the country's economy. Literature on all these factors is available but very scattered.

Some of the factors that affect countries' macroeconomic instability and GDP are structural factors. Because of them, vulnerability arises from several factors linked to economic and political resilience. As far as structural factors are concerned, the difference is between the size and frequency of shocks (commercial or natural) and the country's exposure to such shocks. Factors affecting exposure to shocks (such as population size, degree of economic diversification, distance from global markets, and geographic isolation) increase the propensity of economies to suffer shocks and the negative impact of such shocks on GDP. Macroeconomic stability is affected by the negative relationship between access to global markets and macroeconomic instabilities.

" Countries that are isolated from global markets tend to lack diversity in terms of exports and experience greater macroeconomic instability about GDP. Although it depends to some extent on structural factors, when we analyze the resilience of individual countries, we primarily

think of economic policy and institutions" (Miljković & Miljković, 2010). As a result, development strategies must focus on foreign trade, procyclicality, and countercyclicality of economic policy. The quality of crisis management can determine the magnitude of instability experienced by countries and its impact on their development. The second set examines the sources of macroeconomic instability. They distinguish between external forms (exports, global prices, terms of trade, or international interest rates) and internal forms (economic policy, agricultural production, and natural or climatic disasters).

Similarly, it is possible to distinguish between exogenous sources of macroeconomic instability (related to international trade, agricultural production, and natural disasters) and endogenous sources (related to economic policy instability or domestic socio-political conditions). Finally, several studies distinguish between so-called *normal* fluctuations and *crisis* fluctuations, the magnitude of which exceeds a certain threshold. The paper "On the Economic Vulnerability of Low-Income Countries" (Guillaumont, 2000) highlights the significant contribution made by the size and frequency of external and natural shocks to the structural vulnerability of developing countries.

When analyzing the relationship and possible effects of macroeconomic factors on the GDP of the countries of the Western Balkans, it is necessary to take into account the unfavorable structure of foreign direct investments, export/import, instability of political and social conditions, (non)compliance of legislation with EU regulations and directives, as well as many others factors, positive effects of the analyzed phenomena on GDP cannot be expected in a short period. (Estrin, 2013)

The economy of the Republic of Serbia has experienced significant changes in trade, fiscal, industrial, agricultural, and financial policies in the last two decades. Despite this, the growth trend and structural changes in the GDP of Serbia are still not satisfactory. Many problems are responsible for this unsatisfactory GDP: lack of domestic food production, narrow export structure, increasing import growth rate, failure to attract more foreign direct investment, a dysfunctional banking system with cumulative interest on loans,

continuous loss in public enterprises, poor infrastructure, ineffective taxation, high inflation rate, political instability and serious deterioration of the law-and-order situation. The Republic of Serbia has adopted a set of short-term and medium-term economic management. External factors such as exports, imports, and foreign aid have always played an important role in the Serbian economy, although the relative importance of various external factors has changed over time. Serbia's economy is growing at 4 to 5 percent per year despite inefficient government-controlled enterprises, delays in the exploitation of natural gas resources, insufficient electricity supply, and delayed implementation of economic reforms.

"Recent global financial and economic crisis analyses include the possibility that the crisis has bottomed out and that the worst is behind us. However, since most analysts agree that this crisis will be Z-shaped, we may face another fall before the final recovery. This opinion is shared by some of the leading officials of financial institutions, although they do not rule out the hypothesis that the recovery and the end of the recession may take several years". (Miljković, Miljković, & Miljković, 2012)

3 ECONOMIC CONSEQUENCES OF THE RUSSIAN – UKRAINIAN CONFLICT

Escalating conflict in Ukraine has caused turmoil in financial markets and dramatically increased uncertainty about the recovery of the global economy, two years after the COVID-19 pandemic started. Given that Russia is the world's third-largest oil producer, the second-largest producer of natural gas, and among the top five producers of steel, nickel, and aluminum, any significant reduction in energy supply and metal shipments is very likely to lead to a spike in global prices for these products.

For this reason, on the day the conflict began, financial markets worldwide began to plummet, and the prices of oil, natural gas, metals, and food products (especially grains) rose. While high prices of key products are one of the risks we have already identified as potentially hindering the recovery, the escalation of the conflict between Russia and Ukraine increases the likelihood that

prices of critical products will rise further. In turn, this increases the threat of prolonged high inflation, not least for basic needs, thus increasing the risk of social unrest in both advanced and developing economies. Industries such as automotive, transport, chemical, and generally all sectors that use the above raw materials as inputs appear to be particularly vulnerable.

Many countries reacted immediately after the crisis by easing monetary policy by pumping large amounts of money at very low-interest rates into insolvent banks and other financial institutions. Fiscal policy has stimulated economic activity, but the overall stabilization of the financial system is necessary for long-term recovery, creating conditions for faster economic growth and encouragement of investment in infrastructure and human resources as key factors of long-term growth and unemployment reduction. Macroeconomic imbalances addressing is essential for reducing the possibility of future crises. (Miljković, Miljković, & Miljković, 2013)

While the economic fallout will be felt mainly through rising commodity prices, fueling pre-existing inflationary pressures in much of the pre-conflict world, falling demand from Europe will disrupt global trade. As always when product prices rise, energy and food importers will be particularly affected, and even more so in an environment of uncertain and volatile prices, with the prospect of major disruptions in supply in the event of further escalation of the conflict, and further sanctions and retaliation by each country could undertake.

3.1 Macroeconomic factors affecting GDP

Exports to Ukraine and Russia have fallen significantly and are likely to decline further as a result of a combination of EU sanctions and restrictions imposed by the Russian government and supply issues. Evidence suggests that, even in the absence of legal restrictions, European firms are already reluctant to trade with Russia, fearing legal and payment problems.

According to EU trade statistics, exports of goods to Russia amounted to EUR 89 billion in 2021; and if they stopped, which is an unrealistic assumption, it would, under equal conditions, lead to a decrease in the total demand for goods from the

EU. A decrease in goods exports to Russia by 50 percent would reduce aggregate demand by 0.3 percent of GDP. The European Union also accounts for three-quarters of foreign direct investment in Russia, totaling more than 300 billion euros. We can assume that half of the value of that investment will be lost, which will be around 1% of the EU GDP and slightly less than 2% of their direct investments toward Russia. Although significant for several banks and companies, such a loss cannot be considered of major macroeconomic importance. (EU, 2022)

Evidence suggests, however, that this is unlikely to lead to major problems for the EU's financial system. Branches of Russian banks have already been closed and liquidated without endangering the financial system. The import of non-energy and non-food products from Russia and Ukraine is of minor economic importance. However, their disruption may contribute to the wider disruption of supply chains from the pandemic.

Refugees. The flow of refugees from Ukraine has reached 4.6 million people (not counting the 7.1 million displaced persons in Ukraine) at the time of writing, mostly women and children. Estimated annual fiscal costs of providing accommodation, food, healthcare, and refugee education vary from 9,000 to 25,000 euros per person and year. Assuming the cost of €10,000 per refugee and year, the financing cost for five million refugees for one year is €50 billion, or 0.35 percent of the EU GDP. (UNHCR, 2022)

The outflow continues (albeit at a slower pace), so 5 million, and possibly more, is a likely number. This is a human drama of gigantic proportions and presents great problems in organization and distribution across countries. However, the likely macroeconomic costs appear relatively limited. Even this number overestimates the cost because, in a few months, some refugees will return, some will find work, and some will emigrate from the European Union.

Food. Russia and Ukraine are major producers and, more importantly, major exporters of food, especially wheat. "According to data from the Food and Agriculture Organization (FAO), Russian and Ukrainian wheat exports accounted for 23 percent of world exports and 7 percent of world production in 2019. In Ukraine, planting for the next harvest can be difficult. Distribution

problems, given the fighting in ports along the Black Sea, may further reduce exports. The market price of wheat has already risen nearly 50 percent from \$7.70 a bushel before the war to \$11, a level that was last seen for just a few days in 2008." (FAO, 2022)

Since the European Union is an exporter of agricultural products, global price increases could improve its terms of trade. However, there are two important caveats. The first is that the loss to EU consumers (as opposed to the European Union as a whole, i.e., producers and consumers together) can be large. The second is that elevated food prices are already having dramatic consequences for many emerging markets and developing countries, affecting their growth and macroeconomic stability, and in turn potentially affecting the European Union.

Oil and gas. Energy data is easily confusing due to the heterogeneity of measurement units, so a summary of the situation is a useful starting point. EU energy supply (excluding the UK) relies essentially on oil (33 percent, virtually all imported), gas (24 percent, primarily imported), and coal (12 percent, primarily imported). Other sources include renewable (domestic), nuclear (essentially domestic, as fuel alone is a small part of the total cost), and imported electricity.

Before the conflict, the Russian export price closely tracked the global market price for Brent, an indicator of high substitutability. Russia is one of the several oil suppliers to the European Union. Therefore, we assume the EU can replace imports from Russia with imports from other countries. With lower exports to the West, Russia can partially compensate by selling to India and China.

Unlike oil, the gas market is regional. In simple terms, there are three global markets: Europe, North America, and Asia. Therefore, the relevant market for discussing the impact of the EU sanctions is the European market, not the world market. Electricity production uses approximately one-third of gas. Industry and services also use about one-third, and households use a smaller third. Gas consumption is highly substitutable in some uses. Electricity obtained from other sources can replace gas-fired electricity, but a gas-fired heating system cannot burn oil or coal. "On average, Russian gas accounts for 8.4 percent of the primary energy supply in the

European Union, but there are large variations among member states. For example, Portugal does not import any gas from Russia, but in Hungary, Russian gas accounts for 28.5 percent of the primary energy supply.” (Pisani-Ferry, 2022) Although not fully interconnected (e.g., Spain and Portugal have limited pipeline connections to northern Europe), the European Union can balance price differences to a great extent through internal transactions on imports from the rest of the world.

Inflation. The immediate and most visible macroeconomic effect is inflation. The effect can be quite large. “In 2021, electricity, fuel for heating, and fuel for transport accounted for 9.6 percent of personal consumption expenditures in the Eurozone, and food represented 15.7 percent of the consumer basket on average.” (PKS, 2022) Overall, the share of consumption that is directly affected by price increases is high. Empirical estimates generally show that the transmission of commodity price increases to consumer prices is partial but rapid.

Producers using energy or agricultural products as inputs raise their prices to restore their margins. Workers whose wages lagged in consumer prices in the first round are demanding an increase in nominal wages to restore their real wages. This leads to further increases in prices and wages. All this depends on how hard companies try to restore margins and how hard workers try to maintain their real wages. Ultimately, if commodity prices remain high, inflationary pressures cease only when companies using these products accept lower margins and/or workers accept lower real wages.

3.2 Global macroeconomic effects on GDP

GDP forecasts for 2022 will certainly be reduced considering the Russian-Ukrainian conflict. Production in the war zone will be directly reduced, while economic sanctions will impose costs on Russia and its trading partners. Higher food and energy prices will devalue income realities and reduce consumption and investment worldwide, which in turn will reduce global import demand. A small number of food and energy exporters may benefit from these price movements, but for most countries and the global economy, they are net negative.

The International Monetary Fund's (IMF) latest forecast earlier this year predicted global GDP would grow by 4.4 percent at purchasing power parity in 2022, but a recent estimate had global output growing at just 3.2 percent this year. There is an unusually high degree of uncertainty associated with this projection, which is based on limited data and strong assumptions. As a result, it should be interpreted with caution. (IMF, 2022)

Using a global economic simulation model, the World Trade Organization (WTO) predicts that the crisis and related policies could reduce global GDP growth by 0.7-1.3 percentage points, bringing growth to somewhere between 3.1 and 3.7 percent. The model also predicts that global trade growth could be cut in half this year, from the 4.7 percent the WTO forecast last October 2 to between 2.4 and 3 percent. (Góes, 2022)

Some regions will be more affected by the war than others. Europe, as the main destination for Russian and Ukrainian exports, is likely to experience the brunt of the economic impact. Reduced shipments of grain and other foodstuffs will also push up agricultural prices, with negative consequences for food security in poorer regions. Apart from these first-order effects, economic sanctions could lead major economies to move towards separation based on geopolitical considerations, to achieve greater self-sufficiency in production and trade. This second-order effect would ultimately be a waste, as it would reduce long-term economic growth by limiting competition and stifling innovation.

The main impact of the conflict between Russia and Ukraine on the world economy is reflected in higher energy prices and weaker confidence and financial markets, supported by strong international sanctions against Russia. Ukraine is not a significant trading partner of any major economy. Russia has a large exposure to the European Union and Great Britain. “Countries such as China, the USA, Germany, France, and Italy represent some of the main import partners for Russia, where Russian product demand accounts for between 1-3.7 percent of its GDP (See Figure 1). Russia's share of global GDP is expected to increase in 2022 and will be 1.6 percent, according to the International Monetary Fund, while it is predicted that Ukrainian economic output will make up 0.2 percent of world output.”

(IMF, 2022) While the Ukrainian and Russian economies in the aggregate are small relative to the global economy, they are significant in some key areas, particularly in energy and food. The impact of the conflict on commodity prices, and thus on household consumption, is more important than potential contagion through trade links with other countries.

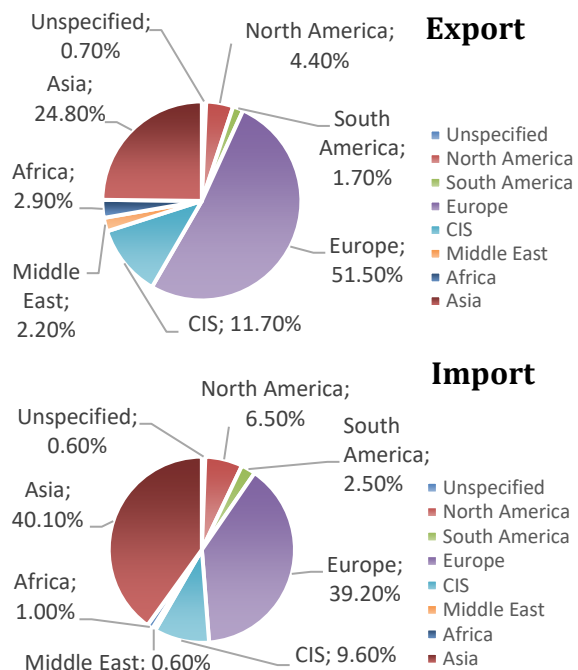


Figure 1. Export and import of products from Russia by region.
Source: (WTO, 2021)

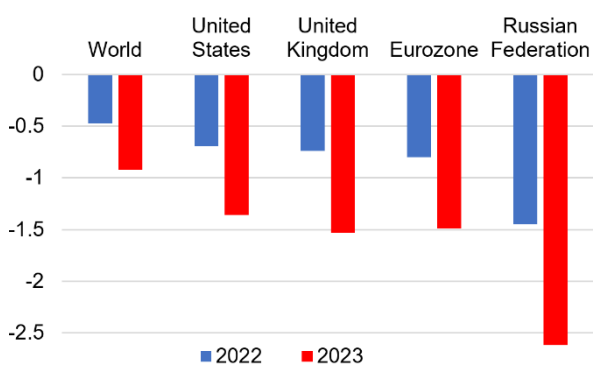


Figure 2. GDP movements due to conflicts in the global economy
Source: (EC, 2022)

All in all, we see that the conflict contributes to the decline of GDP in the world, especially in Russia. (See Figure 2). Global inflation will rise due to higher import prices and higher inflationary expectations. The negative effect will result in lower confidence, lower real incomes, and disrupted trade. Higher energy export revenues

will not fully mitigate the overall effect on the GDP. If the EU extends sanctions to energy imports, the implications for the global economy would be much more severe. Costs would continue to rise, and higher energy prices would be a bigger blow to growth, increasing the chances of a recession followed by significantly higher inflation.

4 MACROECONOMIC EFFECTS ON GDP IN EUROPE

Given the highly uncertain environment, several risks stemming from the conflict and protracted pandemic that could undermine growth stand out. The most worrying risk is the sudden stop of energy flows. However, we can also identify other risks, such as an increase in the risk of social unrest (due to higher food and energy prices, the risk is prevalent in countries hosting many refugees). There is also the risk of another wave of the highly contagious strain of COVID-19.

The main channel through which the conflict in Ukraine and sanctions against Russia affect the Eurozone economy is the rise in global energy prices and energy security. Because they are energy importers, higher world prices represent a negative terms-of-trade shock for most European countries, leading to lower output and higher inflation. Supply chain disruptions have also hurt some industries, including the automotive sector. The special operation and sanctions have further hampered the production of crucial inputs.

As a result, the euro area GDP growth in 2022 has dropped to 2.8 percent (1.1 percent lower than in January), with the biggest drops in economies such as Germany, Italy, and France, which have relatively large manufacturing sectors and higher dependence on energy imports from Russia. Across the eurozone, increased fiscal support partially offset the impact on activity. In the UK, the GDP growth for 2022 has dropped to 1%, with consumption forecast to be weaker than expected as inflation erodes real disposable income. The OECD expects that tighter financial conditions will cool investment. (OECD, 2022)

According to forecasts, EU countries will spend more than 9% of their GDP on energy in 2022. This is the largest share in 40 years and more than double the predicted rates, although two years ago the figures for both economies were around 2%. Higher product prices are exacerbating

already high inflationary pressures around the world. According to the European Central Bank, half of the recent rise in inflation was driven by higher energy prices. (ECB, 2022)

“Because of the sharp rise in commodity prices, the growth index of industrial production prices in the Eurozone countries in March 2022 was 30.9%. In April, it rose to 33.5%. At the end of March 2022, inflation rose for another month in a row and amounted to 7.8% in the EU, while the most affected countries were Lithuania at 15.6%, Estonia at 14.8%, Latvia at 11.5%, and Germany at 7.6%”. (ECB, 2022b) “Consumer prices in Europe rose by 2.5 percent in March 2022 compared to February, seasonally adjusted. However, despite inflation already being high and rising in March 2022, the inflation rate continued to rise in April, to 8.1% (by 0.3 percentage points), to 16.6%.” (ECB, 2022b)

The IMF's latest regional economic outlook for Europe is assumed based on assumptions and identified transition channels, where GDP growth of 3.0% is predicted in developed European economies. Some of the largest economies, such as France, Germany, and Italy, forecast weak or negative quarterly growth in mid-2022. This stall in the recovery is hidden in the annual growth projections for these economies due to a large carryover from 2021. Also, as mentioned earlier, higher product prices and supply disruptions are creating inflationary pressures, which should lead to average inflation reaching 5.5% in 2022 (up 2.2 percentage points from World Economic Outlook projections from January 2022). Inflation is predicted to grow more in countries where food and energy represent a larger share of consumer baskets (Romania, Slovak Republic, and Spain), and where exchange rates have weakened (Hungary, Poland, and Turkey).

Summarizing this section, we note that the increase in inflation in 2021 and 2022 is mainly due to the increase in demand and, accordingly, the increase in energy prices. The main factors that can affect the persistence and even increase of high inflation are shocks in the prices and supply of energy and goods. The high rate of inflation in the EU and several other countries may remain for several years or longer and pose a significant threat to both economies and companies.

5 THE MACROECONOMIC IMPACT OF THE CONFLICT ON THE GDP OF THE REPUBLIC OF SERBIA

The state of the economic environment depends on the totality of macro and micro economic parameters on which the coordinated action of the state and individual circles according to these parameters should ensure such a sustainable economic development of the country or region, it is necessary to have a good resource base and an appropriate macroeconomic policy and to support sustainable competitive winners through continuous raising total productivity. (Miljković, Trnavac, & Veselinović, 2021)

Covid-19 and the conflict between Russia and Ukraine, according to the available data, had less of an impact on Serbia compared to most European countries, due to the achieved macroeconomic and financial stability, growth momentum, fiscal space created in previous years, a large and timely monetary and fiscal package, and the structure of the economy. The economic policy measures adopted by the state minimized the drop in GDP in 2020, while additional aid packages in 2021 contributed to further growth of GDP and its return to the path of sustainable growth in the medium term. The recovery of GDP to the pre-crisis level was already achieved in the first half of 2022, while according to the data of the Republic Institute of Statistics (RZS), real GDP growth at the beginning of 2022 was higher than planned. Such developments are the result of growing activity in the industry, construction, and service sector.

Inflation. Food and energy prices drive inflation. Rising food and oil prices on the world market caused higher inflation in the first half of 2022. These two factors that monetary policy cannot significantly influence conditioned about 70% of interannual inflation. The average inflation in 2021 was 4.0%. Total inflation until June 2021 was 11.9%. Core inflation in the first half of 2022 was lower than overall inflation and amounted to 6.7%, which was contributed by preserving the relative stability of the exchange rate and preserving business and consumer confidence. Short-term inflation expectations of the financial sector hovered around 6.0%. Medium-term inflation expectations of the financial sector ranged between 3.5% and 4.0%. (NBS, 2022)

The main uncertainties of the projection arise from the ongoing conflict in Ukraine, geopolitical tensions, and their impact on the prices of energy, grain, and other products and metals and other raw materials in the future. Risks also arise from the conflict's impact on the global economic recovery and the duration of disruptions in global supply chains. It is also related to the domestic market, the agricultural season, and the movement of regulated prices. Overall, projection risks are elevated and tilted to the upside.

Gross domestic product. In the coming years, Serbia will maintain strong, sustainable, and broad growth, with GDP growth in 2022 revised in the range of 3.5%-4.5%. "Medium-term growth between 4%-5% According to RZS data, in 2021, Serbia achieved real GDP growth of 7.4 percent, fueled by the recovery in the service sectors, as well as the growth of construction and industrial production. GDP growth was 4.4% in the first quarter of 2022. Growth of at least 4% is expected in the second quarter, driven by service sectors and industrial production, despite the conflict between Russia and Ukraine, which has negatively affected supply chains as well as product prices Bearing in mind the uncertainty regarding the further duration of the conflict, as well as the economic effect of rising energy, food and product prices on world markets, they revised down the GDP growth projection for 2022 from a range of 4-5% to a range of 3.5-4.5%. (ekapija, 2022)

Growth is expected to be driven by higher growth in the service sectors, as well as construction and industrial production. In the conditions of the conflict between Russia and Ukraine, the risks of the projection being tilted downwards are assessed. This particularly applies to the supply chain disruption, the energy crisis, and the prices of primary products, as well as the pace of normalization of the monetary policy of the major central banks.

Macroeconomic and financial stability. In the period January-May 2022, the inflow of foreign direct investments (FDI) amounted to 1.14 billion euros (net inflow of 1.0 billion euros), and a full recovery was recorded in May. The processing sectors with the largest inflow of foreign direct investments (metals, cars, food, rubber, and plastics) recorded high growth in employment,

production, and exports. Serbia attracted about 60% of total investments in the Western Balkans region. In 2021, the inflow of FDI amounted to a record-high amount of 3.9 billion euros (net inflow of 3.6 billion euros). In the first five months of 2022, Serbia's balance of payments amounted to 2.3 billion euros. Considering the growth in prices of energy, food, manufactured goods, metals, and industrial raw materials, the projection was revised to 6.5% of GDP. The temporary widening of this gap in 2022 was fueled by global price growth and, on the other hand, the growth of savings in conditions of increased uncertainty. (NBS, Inflation Report, 2022)

The fiscal deficit in 2022 was smaller than planned. Public debt was back on a downward trajectory. Fiscal deficit in the first quarter of 2022 driven by capital expenditures and fiscal support to the population. In 2021, the fiscal deficit amounted to 259.4 billion dinars (4.5% of GDP). The deficit was most affected by the new stimulus package of 2.2 billion euros (4.2% of GDP). (Fiscal Council, 2022)

In the first half of 2022, a consolidated deficit of 58.8 billion dinars was recorded, while the projected deficit is 3.0% of GDP, and its return to 1.0% of GDP in the medium term. The share of public debt in GDP at the end of May 2022 was 52.3% and thus decreased compared to April, primarily due to the reduction of dinar debt. Public debt is expected to return to a downward trajectory in the coming years with further reliance on dinar and euro debt and a reduction in currency risk.

Import/Export. During the pandemic and crisis in Ukraine, new investments and continued expansion of export capacities will ensure high export growth in the medium term. Projections show that the new investment cycle will have increased equipment and raw materials import. The first half of 2022 saw a 32.5% increase in exports of goods, driven by growth in manufacturing and mining exports. The export of services increased by 34.7%. The import of products increased by 46.9% during the first five months of 2022. (Rancic & Stojanovic, 2022) Intermediate products made the biggest contribution, partly due to the rise in energy prices. Serbia's exports are mostly directed to the EU and the countries of the region, and it relies on demand in those countries that recovered during 2021.

By country, the largest share of exports was made to Germany (12.7%), followed by Italy (8.5%), Bosnia and Herzegovina (7.2%), Romania (5.5%), Hungary (5.0%)) and Russia (3.9%). Exports to China in 2021 continued to grow in comparison to 2020 while recording growth in 2022 as well so China is highly positioned on the list of Serbian export partners. (RSZ, Publikacije, 2022)

Job market. According to the employment office, the unemployment rate in the first quarter of 2022 decreased by 2.2% compared to 2021 and amounted to 10.6%. That is below the entire year 2021 average of 11.0%. The employment rate was 49.3%. That is a 3.0% increase compared to the same quarter of the previous year, with an increase in the rate of informal employment from 10.9% to 13.3%. The nominal wages continued to grow faster than annual inflation, which continued real wage growth and preserved the population's disposable income and purchasing power. The average net salary real growth in April 2022 was 2.6%. (RSZ, 2022)

6 CONCLUSION

The Serbian economy ended the pandemic with a minimal recession since the state used most of the available fiscal space during the pandemic beginning. The program's impact on the economy and living standards was favorable, but the financial cost was significant. Due to limited room for future stimulus packages, to return the economy to sustainable growth and secure jobs and incomes while strengthening resilience to shocks Serbia must apply further reforms.

Due to the negative effects of the conflict between Russia and Ukraine, the uncertainty regarding its duration and the economic consequences of further EU sanctions against Russia, and Russia's countermeasures against the EU GDP, the Serbian government revised growth projections for the second part of 2022. For the same reasons, the new average inflation forecast was on a higher path compared to the planned one. In 2022, the account deficit was expected to increase but remain within sustainable limits. Thanks to production-geographic diversification and export-oriented investments, the export of goods increased by as much as 29.1% at the beginning of 2022.

Due to rising food prices and world oil prices, inflation was higher in the first half of 2022. On the other hand, thanks to preserved foreign exchange and macroeconomic stability, core inflation remained stable and lower than overall inflation. The exchange rate's relative stability and businesses' and consumers' confidence contributed to and preserved this. A recovery in the service sector and construction and industrial production growth fueled real GDP growth. The GDP growth in the first quarter of 2022 was driven by service sectors and industrial production, despite the conflict between Russia and Ukraine, which negatively affected supply chains and product prices.

The fiscal deficit increased significantly in 2022 and reached an estimated 8.1 percent of GDP. This increase is primarily the result of the large fiscal stimulus program. Public debt is estimated to be 58.2 percent of GDP by the end of 2022. Supported by significant interventions by the NBS in the foreign exchange market, the Serbian dinar was stable against the euro (the NBS sold reserves worth 1.5 billion euros in 2022).

In July 2022, the NBS decided, for the fourth month in a row, to increase the reference interest rate, driven by persistently high global upward cost pressures due to international energy prices, primary agricultural products, and industrial raw materials, as well as prolonged disruptions to global supply chains, while considering the preserving the continuity of economic growth. The stability of the banking sector has been preserved and additionally strengthened.

Urgent focus is needed on measures to improve the business environment and governance to reduce the cost of doing business and ensure safety and security, as well as efforts to improve the quality of infrastructure. The pace of labor market recovery will be critical to continued poverty reduction. The new package should support citizens and economic recovery. Poor and vulnerable households, more dependent on self-employment and with less secure jobs, may take longer to recover their income levels.

Because of the uncertainty regarding the further duration of the conflict, and the economic effects of rising energy, food, and commodity prices on world markets, they revised the GDP growth projections for 2022. At the time of the special

operation of the Russian Federation in Ukraine and due to assessing the risks, the development projections tend to lower expectations. This is especially true for disruptions in supply chains, the energy crisis and prices of primary products, and the pace of normalization of the monetary policy of the major central banks.

In the medium term, the Serbian economy expects to return to its pre-COVID-19 growth pattern.

However, some challenges will remain and limit growth in the short, medium, and long term. Most importantly, Serbia must continue its efforts to remove the bottlenecks to private sector growth arising from a deteriorating governance environment, underdeveloped infrastructure, and an unreformed education sector that creates growing concerns about skills mismatches.

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FINANCIAL LITERACY AS A FACTOR IN IMPROVING THE WELL-BEING OF THE POPULATION - A REGIONAL ASPECT

Tatyana A. Paladova

FSBEI HE Maikop State Technological University, Department of Finance and Credit, Maykop, Russian Federation

Lyudmila A. Mamiyok

FSBEI HE Maikop State Technological University, Department of Finance and Credit, Maykop, Russian Federation

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Abstract: *The article is devoted to the study of the population's financial literacy as the basis of family well-being. In modern conditions of the expansion of the use of financial services, the complexity, and the emergence of new and difficult-to-understand financial instruments, the issues of financial literacy of the population have become extremely relevant for most countries of the world. Ensuring personal financial security is becoming an important factor in people's economic well-being. The paper studies and summarizes the essence of the concept of financial literacy, highlights the main features of a financially literate person and identifies and considers the main components of financial literacy. It is shown that the role of financial literacy in Russia is sufficiently large and raising its level among citizens is an important task facing the state, the solution of which is very important both for the state and for the economy and citizens. Indicators of the level of financial literacy of the population of the Russian Federation, the dynamics of changes in the level of financial literacy of the population, and the dependence of the level of financial literacy on age have been examined and analyzed in the research.*

Keywords: *financial literacy. population's financial literacy. welfare. financial service. financial services consumer.*

1 INTRODUCTION

Increasing financial literacy is a very significant area of public policy but it is often underestimated. It is the understanding of the basic financial mechanisms among the population that is one of the guarantees of social stability and economic growth of both a separate region and the state.

Increasing financial literacy level contributes to the growth of the quality of financial services and allows expanding the ability of citizens to use financial services more efficiently.

This process reduces vulnerability to financial crises and leads to a gradual reduction in the risks of excessive personal debt of citizens on consumer loans, and a reduction in the risks of fraud by unscrupulous market participants, being an important factor in protecting consumers of financial services.

Address of the corresponding author:

Tatyana A. Paladova

tpalad@mail.ru



2 WHAT IS FINANCIAL LITERACY?

Financial literacy is the ability of a person to manage his/her income and expenses, make the right decisions on the distribution of funds (live within means), and increase them competently. (Maltseva & Paladova, 2019)

In other words, this is the knowledge that allows one to achieve financial well-being and stay at this level throughout life. Financially literate people do not live paycheck to paycheck and take loans only when they are sure that the loan will bring profit in the future. They do not give in to panic even in the conditions of an economic crisis because they have a "reserve fund" in case of various force majeure circumstances. They know how to plan and foresee.

3 FINANCIAL LITERACY IN THE USSR

Unfortunately, a significant part of the Russian Federation (RF) population, one cannot call financially literate. Most of them grew up in a completely different era and did not think about financial well-being in the future and planning the receipts and expenditures of funds on a long-term basis. The generation of the Russian citizens who grew up during the Soviet era cannot teach children and teenagers all the nuances of the world of finance, because they know practically nothing about this field of activity.

In the USSR, there was no stock market. Citizens could only keep their money in one bank, and the only legitimate source of livelihood was wages. And the following facts testify to this:

Many residents of the RF keep money at home in the old-fashioned way, and some do not think about the fact that it is simply vital to save money for rainy days. They are not accustomed to multiplying their capital, and numerous collapses and crises have only reinforced distrust in financial institutions.

Many Russians do not use all kinds of financial services. And not because there is no such need. It is just that people do not understand how it all works and do not even know about financial services. Some citizens of our country still do not know about the deposit insurance system.

Some do not understand how the pension system works (and we are offered to invest in it to receive

a decent pension in the future). The Internet and cashless payments give us many opportunities, but for some, it is easier to withdraw cash and use it to pay for a purchase at the store, even though there is a terminal at the checkout.

4 MODERN FINANCIAL LITERACY

In the modern world, it is necessary to learn how to handle money properly. There is an expression - a penny saved is a penny earned (money likes to be counted). That means it is necessary not only to count the salary or count the change. This is accounting and planning for all expenses. One can even say - planning a life.

A low level of financial literacy negatively affects the personal well-being and financial potential of households, worsens the resource base of financial organizations, impedes the development of the financial market, slows down investment processes in the economy, and leads to a deterioration in the socioeconomic situation of the country. (Mamiyek, Paladova, & Reunova, 2021)

The conducted research and analysis of the opinions of the expert community have shown that a Russian consumer of financial services is characterized by the attitudes of financial behavior associated with the imposition of responsibility for personal financial decisions and financial risks taken on the state (paternalism), as well as a passive attitude to control over personal finances.

In the Russian Federation, much attention has been paid to the issue of increasing the financial literacy level as the most significant factor in the country's economic development and the financial potential of households for the last ten years.

Since 2011 the Ministry of Finance of Russia and the World Bank has been implementing the project 'Assistance in Improving the Level of Financial Literacy of the Population and the Development of Financial Education in the Russian Federation'. In 2017 the Government of the Russian Federation approved "The Strategy for Improving Financial Literacy in the Russian Federation for 2017 – 2023". (Medvedev, 2017)

The development and approval of this Strategy is an urgent and necessary measure to stimulate the economically rational behavior of the population and, as a result, improve its well-being and the quality of life of citizens, including the use of

financial products and services of appropriate quality.

The Strategy's implementation has allowed consumers of financial services to gain the necessary knowledge, increase confidence in the financial system, reduce their financial risks, and improve their well-being.

The study of the level of financial literacy conducted by the NAFI analytical center in 2022 showed an increase in the financial literacy of Russians.

At the beginning of 2022, more than 70% of citizens had a level not lower than the average one, and 58% acquired healthy financial habits:

they manage the family budget, control expenses, and make savings. (NAFI, 2022)

The NAFI Analytical Center has been measuring the financial literacy of Russians for more than ten years.

Since 2018 the Financial Literacy Index has been used to measure the level of financial literacy, reflecting a person's ability to manage personal finances prudently. This indicator is measured in the range from 1 to 21 points.

According to the latest research, conducted in December 2022, the financial literacy index of Russians was 12.79 points (an increase of 5.5% compared to the value of 2018 - 12.12 points).

Table 1 - The value of the index of financial literacy of Russians, in points

Years	2018	2020	2022
The index of financial literacy	12.12	12.35	12.79

The most financially literate Russian residents are men and women over 45, have higher education, and are residents of large cities. A low level of financial literacy is typical for non-working Russians, and residents of rural or remote areas.

In dynamics over four years, the proportion of Russians with high and medium financial literacy is gradually growing, while the proportion of Russians with low financial literacy is decreasing.

Table 2 - Shares of Russians with low, medium, and high levels of financial literacy, in %

	2018	2020	2022
Low level of financial literacy (1-11 points)	44	41	28
Medium level of financial literacy (12-15 points)	46	47	57
High level of financial literacy (16-21 points)	10	12	15

In 2018, 44% of the inhabitants of the RF showed a lack of knowledge of financial issues, and lack of competent financial planning skills, and attitudes toward achieving long-term financial goals.

Today the number of Russians with a low level of financial literacy is slightly more than a quarter, i.e., 28% (a decrease over four years by 16 p.p., by 3 p.p. from 2018 to 2020, and by another 13 p.p. from 2020 to 2022).

The share of Russians with an average level of financial literacy has increased by 11 p.p. since 2018. (2018 - 46%, 2020 - 47%, and 2022 - 57%).

The growth of the financial literacy of Russians in the period under review is primarily ensured by the flow from the low category to the medium one. This trend has been observed clearly over the past

two years, during which the coronavirus pandemic and changes in the socioeconomic situation occurred.

Table 3. - The value of private indices of financial literacy of Russians, in points

	2018r.	2020r.	2022r.
Private Index Knowledge	4.55	4.68	4.19
Private Index Skills	4.78	4.89	5.75
Private Index Principles	2.79	2.79	2.86

Financial literacy is a certain level of knowledge, skills, and abilities that allows a family to objectively assess the economic situation, the situation in the country, and other components and, based on this, make rational and necessary

decisions in managing personal financial resources.

Over the past four years, a significantly bigger number of people began to maintain a family budget in one form or another, fix their expenses and strive for a balance between income and expenses. That is an increase of 18 p.p. to 65%.

The share of those who saved money for something during a year increased by 33 p.p. (73% in 2022). 78% of Russians began to monitor the state of their finances more closely (in 2018, this share was 70%).

Negative trends include an increase in the share of those who have experienced a situation where their income is not enough to cover all living expenses (48%, for 17 p. p. more; a decrease in the share of those who know that they can lose all their money if you save them in only one place (58%, 8 p.p. less). Russians also more frequently began to find it difficult to calculate interest on loans and deposits (by 11 p.p. or more, depending on the issue).

An analysis of private indices of financial literacy shows a systematic and steady increase in people's financial management skills and a slight increase in competent attitudes and ideas about finance. And only financial knowledge, on the contrary, demonstrates a negative trend.

The result of the implementation of the Strategy is the achievement of the main goal, which is creating the foundations for the formation of financially literate behavior of the population as a necessary condition for the financial well-being of households and ensuring sustainable economic growth.

This Strategy is the basis for the development of state programs of the Russian Federation and the constituent entities of the Russian Federation. As part of the Strategy in the Republic of Adygea implementation, the State Program 'Improving the level of financial literacy of the population in the Republic of Adygea' operates.

The goal of the State Program is to promote the formation of reasonable financial behavior among the population of the Republic of Adygea, a responsible attitude to personal finances, and increase the effectiveness of protecting their interests as consumers of financial services.

The sociological research "Financial literacy of the inhabitants of the Republic of Adygea" was carried out in 2022 as a part of the implementation of the action plan for the State Program of the Republic of Adygea "Improving the level of financial literacy of the population in the Republic of Adygea for 2021-2023".

The studies coincided with a significant change in the situation in the global economy, including the Russian economy caused, on the one hand, by the COVID-19 coronavirus pandemic, which harmed all spheres of society, intensified the economic crisis, demonstrating how much the population is financially vulnerable, and the introduction of unprecedented sanctions against Russia, on the other. (Alikaeva, Ksanayeva, & Prigoda, 2020)

The studies were carried out on a representative sample by the method of face-to-face questioning in the administrative districts and cities of the Republic.

The study determined the level of financial literacy, financial behavior, and financial attitudes of the respondents. The respondents had different understandings of what financial literacy is. The most popular definitions boiled down to the following: financial literacy is "the ability to effectively manage personal finances" (64%); "the ability to competently keep records of their income and expenses" - (68%); "the ability to use up-to-date information on the situation on financial markets" (40%); "the ability to understand the peculiarities of financial products and services" (40%). Some also said that "this is a fictitious concept that has nothing to do with real life" (2%). 2% of respondents found it difficult to answer the question. The definitions of financial literacy given by the respondents generally correspond to the definitions obtained in the course of previous studies and indicate a quite adequate identification by the respondents of a range of problems that correspond to the problem of interest to us.

The conducted studies showed that the residents of the Republic still have a satisfactory level of financial literacy (if you evaluate it on a five-point scale of "excellent", "good", "satisfactory", "bad", and "very bad").

Increasing the level of financial literacy of the population is extremely important at the present stage of the development of society and is dictated

by the peculiarities of the development of the financial market. An appropriate level of financial literacy helps a person to accumulate economically valuable knowledge, makes financially behavior more productive, and helps to improve the standard of living of citizens by rationalizing the family budget, developing the ability to manage finances and, as a result, contributes to the growth of the well-being of the population. (Cekerevac, Dvorak, & Prigoda, 2022)

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IMPACT OF DIGITALIZATION ON THE WORLD ECONOMY DEVELOPMENT

Lyudmila Reunova

Department of Finance and Credit, Maikop State Technological University,
Maikop, Russia
<https://orcid.org/0000-0001-5814-3942>

Zarema Namitokova

Department of Finance and Credit, Maikop State Technological University,
Maikop, Russia
<https://orcid.org/0000-0001-5814-3942>

Madina Alikaeva

Department of Economics and Accounting and Analytical Information
Systems, Kabardino-Balkarian State University, Nalchik, Russia
<https://orcid.org/0000-0003-1493-6320>

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Abstract

The choice of this research topic is reasoned of the relevance of the digital economy in the modern world. It impacts the economies of various countries, both at the micro and macro levels, as well as their economic growth trends. The relevance of a systematic study of digitalization is a priority both at the global and regional levels. The aim of the study is a statistical assessment of the impact of digitalization on world economic development, as well as a digitalization assessment on all levels of the world countries. To achieve this goal, the following research tasks were identified: to assess the current level of development of the digital economy, study the impact of digitalization on GDP, and identify trends and prospects for digitalization as a global process. The methodology of the research conducted by the authors is based on general scientific methods of cognition: analysis and synthesis, historical and comparative methods. The study of the state and development of the digital economy conducted by the authors made it possible to identify and determine the motivational direction of introducing digital technologies by organizations and companies, due to obtaining competitive advantages. All conditions and opportunities have been created in full to implement the development of the digital economy in many countries.

Keywords: Digital economics. Economics of innovation. Innovations. Digitalization.

Address of the corresponding author:
Madina Alikaeva
[✉ alika123@rambler.ru](mailto:alika123@rambler.ru)

1 INTRODUCTION

In recent years, we have seen a rapid change in world processes, including economic ones. The

reason for this is digitalization, which includes high-tech digital technologies development and implementation in all spheres of human life and contributes to the entry of states and society into an era of global change.

Digitalization covers several areas: big data, artificial intelligence, wireless communications, virtual and augmented reality, blockchain, cloud

computing, smart homes, the Internet of Things, robotics, and 3D printing. According to a study by MGI (McKinsey Global Institute) conducted in 2017, every second an inhabitant of the Earth had a connection to the Internet (Osipovskaya, 2019)

The level of digitalization in many countries, for example, in the E. U. countries, exceeds 50% (Fig. 1).

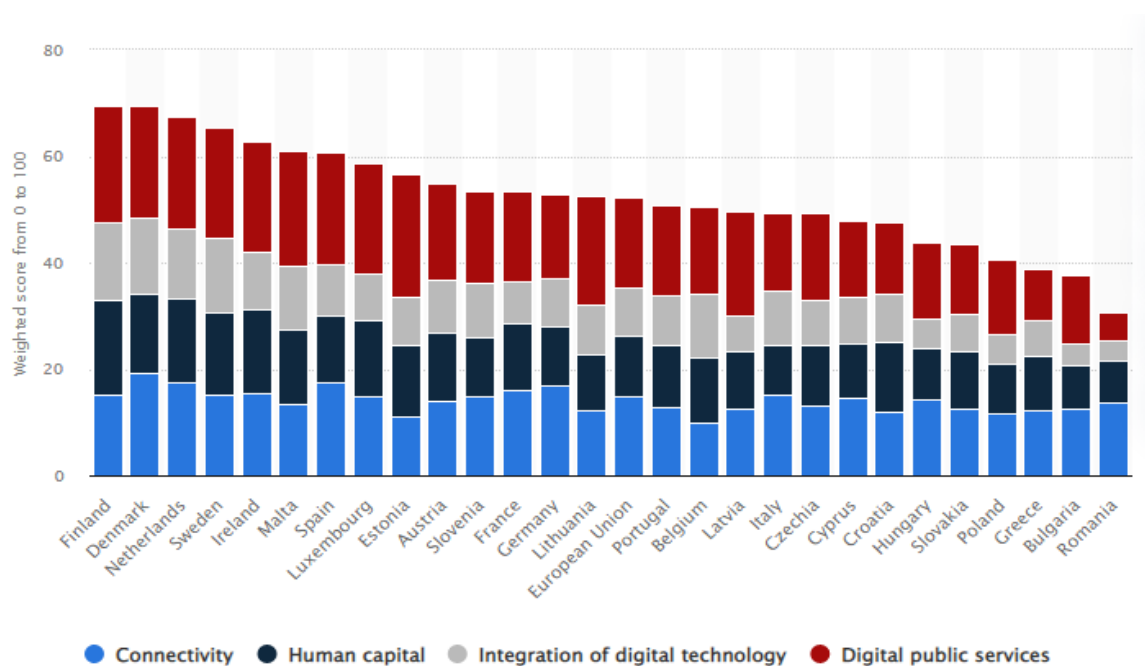


Fig. 1. Digitalization level of the European Union in 2022, by country (index score)

Source: (Petrosyan, 2023)

The world economy, like other areas, cannot remain detached from scientific and technological progress. Therefore, digitalization also affects it. Digitalization leads to qualitative structural economic changes, so the "digital economy" emerges.

2 DEFINITION OF THE DIGITAL ECONOMY

The term "digital economy" refers to 1995. During this time, it was associated with the intensive growth of information and communication technologies. However, despite the long period of use of the term, neither Western nor Russian scientists currently have a well-established meaning of the term "digital economy". In this connection, there are many definitions of the digital economy.

Among the authors studying digitalization, the most notable are K. Schwab, A. Shane, C. Perez,

D.G. Rodionov, A.E. Skhvediani, A.A. Bondarev, E.V. Ustyuzhanina, and A.V. Sigarev.

The World Bank made one of the definitions of the digital economy. It defines the digital economy as a system of economic, social, and cultural relations based on using digital information and communication technologies (Mitin, 2017).

In the publications obtained because of statistical calculations, there is a significant number of others but in the Russian Federation, narrower values are excluded than in the publications, and sources are identified (Golovenchik, 2019).

Particularly, in Russia the official definition of the digital economy is different. "The digital economy is an economic activity in which digital data is felt, the large volume processing and the use of analysis results, which, in comparison with the identification and forms of management, can increase the efficiency of various types of production, technologies, equipment, storage,

sale, delivery of goods, and services" (Kozyrev, 2017). In the definition's interpretation, special attention is paid to information (data) in digital format, which allows you to understand the essence of this term correctly.

In all cases, the authors we agreed with, recognize the leading role of information and communication technologies, primarily the Internet, in the modern economy and that they have become the basis of the emerging VI technological order. In the economic, political, cultural, social, and other spheres of human life, we are seeing changes caused by information and communication technologies, indicating the start of a new stage of informatization, called the "digital economy" (Golovenchik, 2019).

The digital economy acts as a strategic direction of development based on expanded reproduction with an increasing role of traditional and intellectual resources and increasing their differences (Morozko, Morozko, & Didenko, 2022).

3 THE ROLE OF DIGITALIZATION IN THE ECONOMY

The digitalization process is progressive. It has a positive effect on developing relationships in society and increases the convenience of

transactions for all participants: citizens, businesses, and government agencies.

According to experts, digitalization makes it possible to optimize production and logistics operations, increase the efficiency of the labor market, equipment productivity, and R&D efficiency, and reduce resource consumption and production losses (Osipovskaya, 2019).

In the economy, digitalization has become one factor of competitiveness - the higher the level of digitalization, the higher the competitiveness. And this applies to individual companies, industries, and national economies. According to a study by MGI (McKinsey Global Institute, based on the Digital Quotient), enterprises that are more actively adopting digital technologies show higher financial results (Aptekman, et al., 2017).

The COVID-19 pandemic and the massive transition to remote work in almost all countries have stimulated digital transformation processes and increased costs for individual digital solutions that allow organizing remote interaction between employees. (Cekerevac, Dvorak, & Prigoda, 2022)

Most global companies are actively considering the ecosystem business model currently since in the last 5 years it is these companies that have shown the greatest growth in value (Fig. 2).

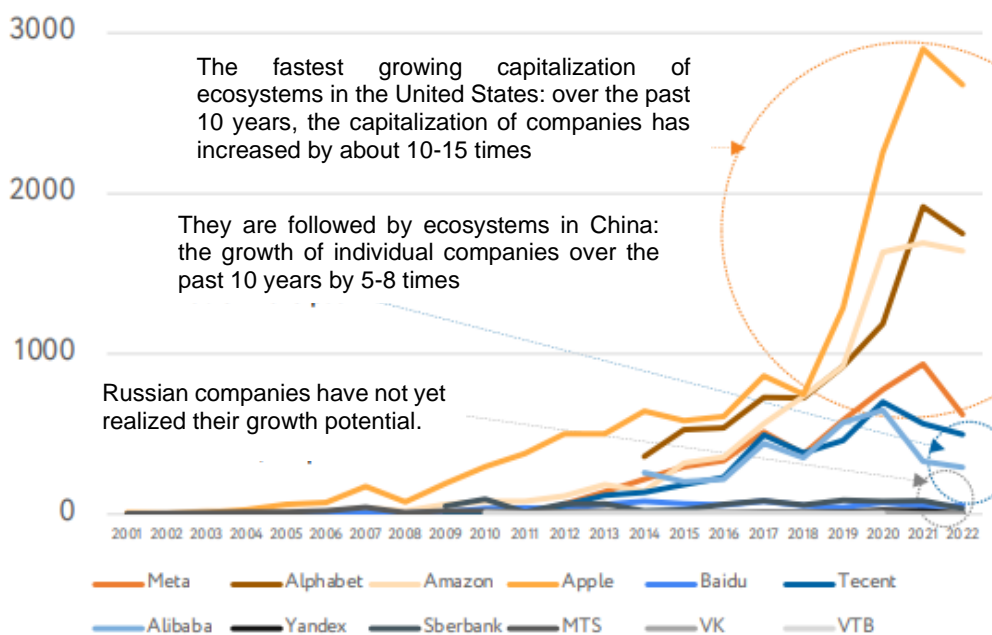


Fig. 2. Capitalization of the largest ecosystems (IEP, 2022)

McKinsey estimates that ecosystem companies could generate \$60 trillion in total revenue by 2025, with a potential increase in global economic

share from 1 to 2% in 2020 to 30% of global GDP by 2025 (IEP, 2022).

Developing ecosystems can lead to an increase in the rate of economic growth, an increase in the productivity of companies, the innovative activity of companies in the economy, expand international trade, and also affect the labor market, inflation, and other macroeconomic variables.

Table 1. *Impact of digital ecosystems on national markets (IEP, 2022)*

Index	Influence
Economic growth rate	Growth in economic growth due to direct influence; reduction of transaction costs; firm productivity growth.
Companies' performance	Positive due to reduction of information asymmetry between market parties; the departure of the least productive players and the growth of competition between the remaining ones; reduction of transaction costs in the interaction of players in the market. Negative due to the risk of markets being monopolized by one platform; breaking existing value chains.
Consumer Experience	Possible multidirectional influence: Growth in the number of participants in platform markets due to the emergence of new services, saving time when interacting between market participants online. Improving the usability of services through a single point of access to different categories of services, loyalty programs, and savings through package offers. Reduced user interest in platforms in case of discriminatory personalized pricing, which may discriminate against users based on biased criteria, as well as due to the risk of data loss (including payment data and document data).
Inflation and prices of goods and services	Decrease in inflation in case of increased competition between players and reduced information asymmetry. Increase in prices in case of monopolization of markets and implementation of the winner-take-all effect (typical for non-digital companies as well)
International trade	It contributes to the growth of international trade by reducing the transaction costs of buying goods abroad.
Labor market	Reduces transaction costs and allows companies to transfer part of their services to outsourcing. The development of freelance platforms can lead to an increase in the flexibility of labor supply and demand, a decrease in geographical barriers in the labor market, and an increase in the number of employees by attracting people with disabilities.

However, digitalization brings not only advantages but also certain risks, presented in the World Bank report on the state of the digital economy "Digital Dividends" back in 2016 (World Bank, 2017). Among the positive results of its development, the following were highlighted:

- increase in labor productivity;
- reduction of production costs;
- increasing the competitiveness of companies;
- creation of new jobs;
- better satisfaction of people's needs;
- overcoming poverty and social inequality (which raises doubts).

The risks of digital transformation of the economies of various countries included:

- risks associated with cybersecurity;
- a massive rise in unemployment;
- the growth of the "digital divide" in education, in terms of access to digital services and products, as a result - in the level of well-being between citizens and businesses within countries, as well as between countries.

A careful consideration of the positive and negative aspects of digitalization for the economy shows that negative trends can cause some damage to the quality of life of most of the country's population. In addition, there is a risk of technology being misused and the spread of digital fraud.

3.1 Digital transformation and GDP

In the future, the international competitiveness of countries will depend more on the speed with which digital technologies are introduced into the production process. At the same time, the possibility of implementing digital transformation depends on the availability of the necessary resources for it. In turn, the quantity and quality of available resources largely depend on the achieved level of economic development, measured by the real gross domestic product (GDP) per capita level. Digitalization has a positive impact on the GDP per capita, employment rate, and employment growth. As of the end of 2021, GDP per capita in Western countries had the highest values (Fig. 3) (Kodzasova, 2021).

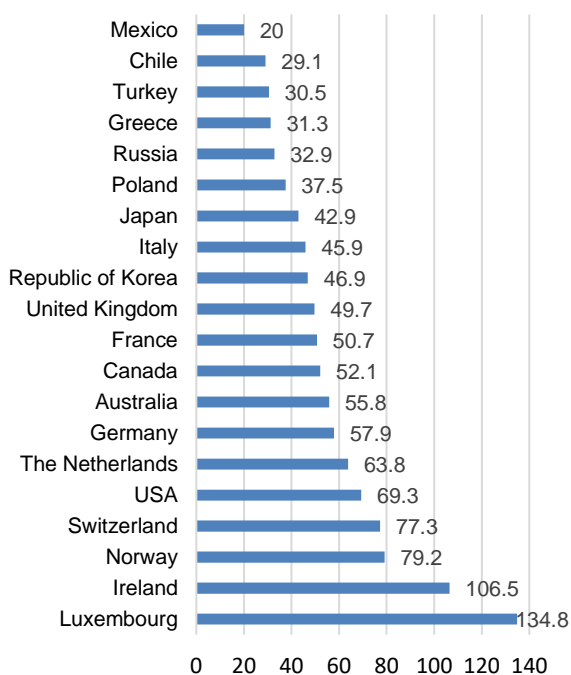


Fig.3. GDP per capita, 2021, in thousand U. S. dollars (Rosstat, 2022)

If these countries continue to develop using digital technologies, they will become even more competitive. And GDP per capita will continue to grow even more rapidly (Kodzasova, 2021).

In connection with the development of digital transformation processes, let us consider its impact on economic growth in countries worldwide based on an analysis of the dynamics of global GDP (Fig. 4).

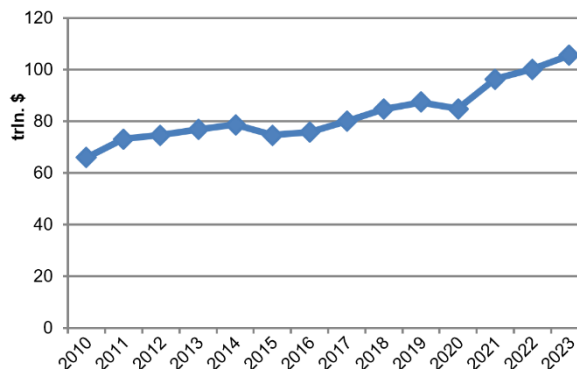


Fig.4 Global GDP for 2010-2023 – Compiled from (iFinance, 2019)

Figure 5 shows the structure of global GDP.

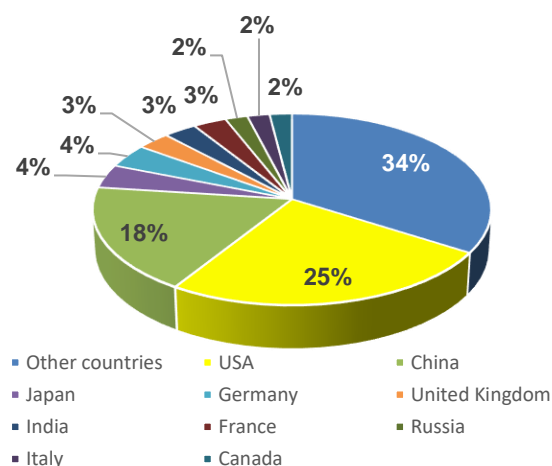


Fig.5. Structure of global GDP for 2022 – Compiled according to (Semenova, 2023)

The presented data imply that, in the period from 2010 to 2022, global GDP had a positive trend. According to the IMF, in 2022, the global GDP of the world for the first time exceeded \$100 trillion and amounted to \$100.22 trillion. Compared to last year, global GDP grew by 3.4% (iFinance, 2019).

According to the World Bank, in 2022, five countries form the basis of global GDP, the United States, China, Japan, Germany, and India, account for just over half of the global figure (Bely, 2023).

The United States is the leader in terms of GDP. In 2022, their figure increased by \$2.1 trillion and amounted to \$25 trillion. The US accounts for almost a quarter of the world's GDP (24.6%). A distinctive feature of the United States is the strong predominance of the service sector in the structure of GDP - it accounts for 80.2% of the indicator, while industry accounts for 18.9%, and

agriculture in the country's structure's GDP takes only 0.9%.

China occupies the second position in the world's GDP ranking. In 2022, the country's GDP grew by \$1.4 trillion and amounted to \$18.3 trillion. China accounts for 18% of the world's GDP. If it unites the economies of the USA and China, we will get approximately 43% of the world economy.

Japan the world's GDP is close to the top three. The country's economy produced \$4.3 trillion worth of goods and services in 2022, which is \$0.8 trillion less than in 2021. Japan's share in the world's GDP in 2022 has decreased and is 4.2%. Japan's economy is one of the most innovative and high-tech in the world. The share of services accounts is 68.1% of GDP, and industry - 30.1%.

Germany is the EU's leading economy, accounting for 27% of the Eurozone's total GDP, and is the EU's leading exporter. In 2022, Germany's GDP amounted to \$4 trillion, which is \$0.2 trillion more than last year. The share of Germany in world GDP is 3.9%. The service sector in the country accounts for 68.6% of GDP, industry - 30.7%, and agriculture accounts for only 0.7%.

The Indian economy in the structure of the world's GDP rose to fifth place. India's GDP in 2022 reached \$3.5 trillion, or 3.4% of global GDP, and since 2021, the figure has grown by \$0.6 trillion. The main factor in the growth of the Indian economy was a transition from a planned distribution to a mixed economic development model (China had taken the same path in the past). The share of the service sector is 54.3% of Indian GDP, a figure that exceeds that of China and approaches that of developed countries (Belyy, 2023).

Countries that cannot achieve digital transformation are gradually losing competitiveness, and their GDP is declining. That applies not only to economically weak countries but also to those heavily indebted, such as Greece and Italy, and to aging societies in which innovation power and productivity are gradually declining. Many Asian countries in 20 years are characterized by strong economic growth, that is, they have financial resources for digital transformation. This applies to China, South Korea, Indonesia, Thailand, and Taiwan. African countries, although they have a young and growing population and resources, still cannot

create a digital infrastructure and promote the education sector, which hinders their economic growth (Kodzasova, 2021).

3.2 Prospects for Digitalization in the Economy

Over the past few years, technology has brought about a digital turnaround in the economy and has significantly changed trade.

Every year, the World Trade Organization (WTO) records the growth of the global economy under the influence of digital technologies. Its growth in 2022 may slow down 2023 as multiple shocks weigh on the global economy. WTO economists predict that the global merchandise trade will grow by 1.0% in 2023, well below the previous estimate of 3.4% (WTO, 2022)

Developing digital technologies has led to such global trends as:

Increase in imports and exports. Because of the emergence of online stores, streaming platforms, and social networks, international trade has become more accessible. Trading platforms create unlimited potential for the sale of goods and services, connecting buyers around the world.

The simplification of financial transactions. Online wallets, blockchain, and cryptocurrencies have made cross-border financial transactions much easier. The speed of transactions has increased, and financial market participants have received inflation protection and a lower commission (n. d., 2022).

The following digital technologies had the greatest impact on the economy in 2022:

- *Blockchain* is a ledger for storing and transferring digital assets, which works in two directions: Buying, selling, and storing cryptocurrency and logistics. Based on blockchain, it is possible to organize document flow in a single digital system of the company. That is especially true for international companies that supply their products to different countries, which increases the supply chain from raw material sellers to points of sale. Blockchain allows them to create a single registry of documents with certificates, licenses, contracts, reports, etc. Also, they can track their products in real time.
- *Livestream shopping* - selling a variety of goods live.

- *VR-reality, augmented reality*, is actively used by brands to reduce the gap between the product and the buyer. With the help of this technology, you can see the subject in detail or get additional information about it.
- *The Metaverse*. That is a new but already actively developing technology. The fashion industry, and for example, the house of Gucci,

considers the metaverse as a platform for holding fashion shows and communicating with customers worldwide (n. d., 2022).

When sufficient investment is achieved, digitalization will become one of the main factors of economic growth (Fig. 6).

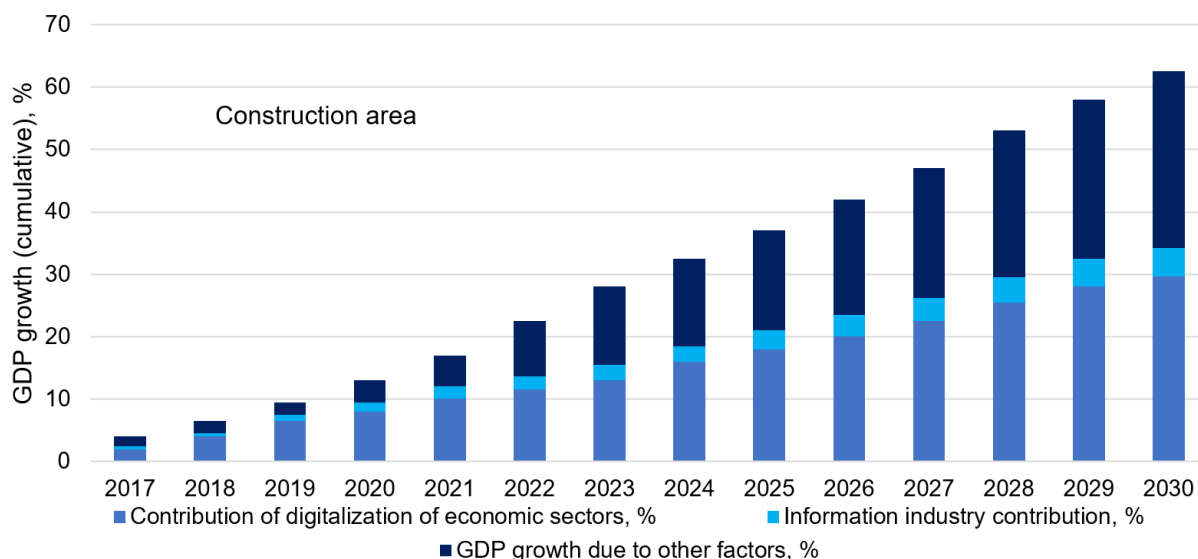


Fig.6. *The contribution of digitalization to economic growth* (Dranev, Kuchin, & Fadeyev, 2018)

We assume that by 2030, GDP growth of over 50% will be associated with digitalization and will be ensured by developing the information industry and increasing the efficiency and competitiveness of all sectors of the economy. In particular, for 2017-2030, the information industry contributing to GDP growth will be almost 4%, and the digitalization of economic sectors will be approximately 30% (Dranev, Kuchin, & Fadeyev, 2018).

4 CONCLUSIONS

Based on the conducted research, we made the following conclusions. The digitalization of the economy in the modern world has a strong and complex impact on the economy. At the same time, the main trends in digital development are formed mainly by countries engaged in a specific development in the digital sphere and the massive introduction of digital technologies.

The digitalization of the economy and economic growth are interrelated. Countries with a high

share of the world's GDP also have a developed digital economy sector, as they widely introduce digital technologies in agriculture and industry. Accordingly, digitalization drives economic growth in the modern world (Iordanova & Cherenkova, 2022).

However, even if digital technologies have proliferated in most countries, the digital dividend - the broader development benefits from these technologies' use is lagging. While digital technologies have often spurred economic growth, created opportunities, and improved service delivery, overall, the cumulative impact of their use has either been much weaker than expected or not dispersed. Overcoming the digital divide is connected, first of all, with the organization of ubiquitous access to the Internet. Also, states need to improve legislation, develop the competition, improve the workers' skills under the digital economy requirements, and ensure the accountability of institutions (World Bank, 2017).

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THE MECHANISM OF DIGITAL TRANSFORMATION OF AGRICULTURE

Zalina Kh. Shogentsukova

FSBEI HE Kabardino-Balkarian State University named after HM. Berbekova (KBGU), Nalchik, Russia

<https://orcid.org/0000-0002-6808-324X>

Ali Kh. Shogentsukov

FSBEI HE Kabardino-Balkarian State University named after HM. Berbekova (KBGU), Nalchik, Russia

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Abstract

The article is devoted to the study of the construction of the mechanism of digital transformation of agriculture when building a management system for agro-industrial clusters. The new realities of socioeconomic relations at the international level and the level of individual states require involvement in digitalization trends. That makes it necessary to study the mechanism of digital transformation of the branches of the national economy, including agriculture. The use of new IT technologies contributes to the formation of competitive advantages and directions for the development of the industry. On the other hand, it acts as an incentive to activate and increase the efficiency of the management system by stimulating the introduction of achievements and trends in modern science and technology, which is especially important in the digitalization and digital transformation of agriculture. Accumulation, systematization, and generalization of traditional-historical and modern IT technologies and management system techniques is an element of integration and activation of network, cluster, and other innovative mechanisms in the modernization of the management system in the agro-industrial complex. The development of the agriculture digital transformation will allow to specify of the tools and methods of updating and building integrated management systems of system-forming innovative agro-clusters will allow to generalize of the theoretical and methodological foundations, and develop recommendations for the formation of a management model of system-forming innovative agro-clusters using the concept of "triple helix" and modern digital technologies in the field of agro-industrial complex of Russia.

Keywords: *digital transformation, management systems, agro-clusters, agro-industrial complex, triple helix model, digitalization, agriculture, artificial intelligence.*

Address of the corresponding author:

Zalina Kh. Shogentsukova

[✉ zsh27@yandex.ru](mailto:zsh27@yandex.ru)

1. INTRODUCTION

The change in the general paradigm of the capitalist to the post-capitalist social way of life and the transition from the industrial to the post-industrial mode of production led to the modernization of coordination and the construction of the structure (model) of communication, which in turn led to an evolutionary transformation of the management system. Analysis of the evolution of world relations makes it possible to generalize, systematize, and conditionally single out three control systems for various spheres of society:

1. Hierarchical,
2. Market,
3. Integrated network.

As practice shows, the formation of a three-tier management system took place, on the one hand, under the influence of the information needs of society, the state, the economy, and science, and on the other hand, the need to expand the coordination system of network connections and increase the efficiency and mobility of the management system itself in the course of using innovative and digital collection tools, processing, storage, and use of information.

The evolution of management systems is characterized by a gradual transition from a rigid model of connections (hierarchical) to a flexible one - integrated (network), which assumes the most flexible model. In doing so, it is necessary to observe certain restrictions. In the process of evolutionary development, the number of subjects of management expands through a gradual transition from a sole to a chaotic management system. That leads to the absence of partnerships between the main participants and the emergence of vertical ties, where the subjects of management are not one governing center but a "symbiosis" of the major participants. Such a new management system contributes to the emergence and functioning of agro-clusters - as backbone and innovative management systems. We agree with the opinion of N. Smorodinskaya, who notes that "the systems headed by the control center cannot cope with the increasing flows of information and are increasingly being replaced by network systems built on horizontal (non-hierarchical) connections and the principle of collaboration" (Smorodinskaya, 2011, p. 67). In our opinion, the

use of the principle of collaboration in the process of creating and functioning of agro-industrial clusters (agro-clusters) will make it possible to intensify the interaction, cooperation, and exchange of knowledge, technologies, and other resources between core stakeholders, and coordination in a single space of the control system. Clusters are becoming one of the crucial platforms within this management system since they act as a structuring element in the world economy development.

The instrument for the implementation of the new management system is the concept of the "triple helix" - a collaboration of the state, business, and science, taking into account the factor of digital transformation, digitalization of economic processes, and the intensification of the use of digital technologies and the achievements of scientific and technological progress, which is especially important for agriculture. Historically, the concept of the triple helix originated in the 90s in the field of sociology and biology. This model bases on the spiral of G. Itskovits, who defined it as "an attempt to represent visually the variability and flexibility of interactions ... the model invisibly contains the fourth element - time, around which, changing and developing, all three spirals wind" (Etzkowitz, 2008). The use of the triple helix model in the agro-industrial complex makes it possible to build innovative backbone clusters, the determining factor being the network connections that arise in the control system. According to many authors, "the active development of networks in modern markets is determined by the possibility of saving costs and combining the resources and abilities of participants, which allows them to jointly create additional value and receive mutual benefits from network interaction, achieving a common goal" (Oborin & Sheresheva, 2017, p. 27).

Since the agro-industrial complex of Russia can provide the population with the necessary amount of food, trends and the general vector of its development become part of state policy and priority national projects implemented at the macro, meso, and micro levels. In the current conditions, the construction of an effective management system for agro-industrial clusters is impossible without the active use of digital technologies and innovations, which is "due, on the one hand, to the activation of the general

strategy of digitalization of the economy as a whole, as well as the need to introduce scientific achievements and technological progress into the management system of the agro-industrial complex of Russia, to increase its efficiency and competitiveness of the industry" (Shogentsukova & Shogentsukov, 2020).

The inhibition of the efficiency of agricultural development is due to several factors: the non-systemic nature of the industry management system both at the level of its participants within the agro-clusters and at the state level; a low level of understanding of the need to rank and justify a phased transition to the digital transformation of agriculture and its gradual transformation into an ecosystem, as well as the lack of interconnection between the processes of adoption at regional and federal levels of state power, state programs in the field of agricultural development, fragmentation of methodological and information support, unsystematic management in the agro-industrial complex, causes the need to study the modernization of the management system of agro-industrial clusters (agro-clusters) in the context of digitalization.

2. MATERIALS AND METHODS

The Russian Federation possesses vast territories and a complex management structure for the agro-industrial complex, due to the diversity of the production process of agricultural products and schemes of interaction between participants in agricultural production, from the preparatory processes, and production to the promotion (sale, marketing).

In the course of studying the evolution and modernization of the agro-cluster management system, the methodological basis is a set of scientific, interdisciplinary approaches, including a systematic approach, including general scientific and specific methods: systematization and generalization, comparison, historical and structural-system analysis, used in various combinations to solve the set goals and tasks, ensuring the formulated conclusions and recommendations.

The study of the modernization and development of the management system in the field of agriculture contributes to the systematization and building of a system for coordinating the directions

of interaction between the core participants in all processes of the agro-industrial complex within a single space, for example, a cluster - as a system-forming and self-developing system of management of the country's agro-industrial complex in the context of digital transformation and digitalization of all processes Agro-industrial complex.

The systematization of the development of economic and social relations in the world conditionally allows us to distinguish the three management systems presented in Fig. 1.

The evolutionary development of the management system in the field of the agro-industrial complex makes it possible to single out several points:

1. *Hierarchical management system - assuming an administrative-centralized management system with a rigid model of connections.* The main subjects of management are the state and the company. The management system is built within a rigid hierarchy and with a vertical chain of command and coordination in decision-making. This system is a classic management system for both the economy and the state as a whole. The most striking example is the Russian economy of the Soviet Union period, characterized by a rigid unification of all processes and the management system itself. We agree with Polbitsyn's opinion. He notes that "rural entrepreneurs rely on their resources and capabilities, and also government and local government bodies" (Polbitsyn, 2019, p. 305). The main participants in agricultural production are quite skeptical about digitalization and the introduction of innovations since individual enterprises do not have sufficient resources for innovative activities development and cannot act as a "growth point" (Shogentsukova & Shogentsukov, 2020).

The transition from the classical to the market and then to the integrated management system is closely related to the change of economic systems: command-administrative to market industrial, which requires the active use of digital, including online, technologies for coordinating the management system. In

modern economic relations, the presence of price and other market benchmarks becomes insufficient; coordination between producers and the consumer becomes necessary not only through traditional communication methods but also through network

communications using Internet technology. By formatting databases, large Internet companies create an entirely new environment for economic relations, including agriculture.

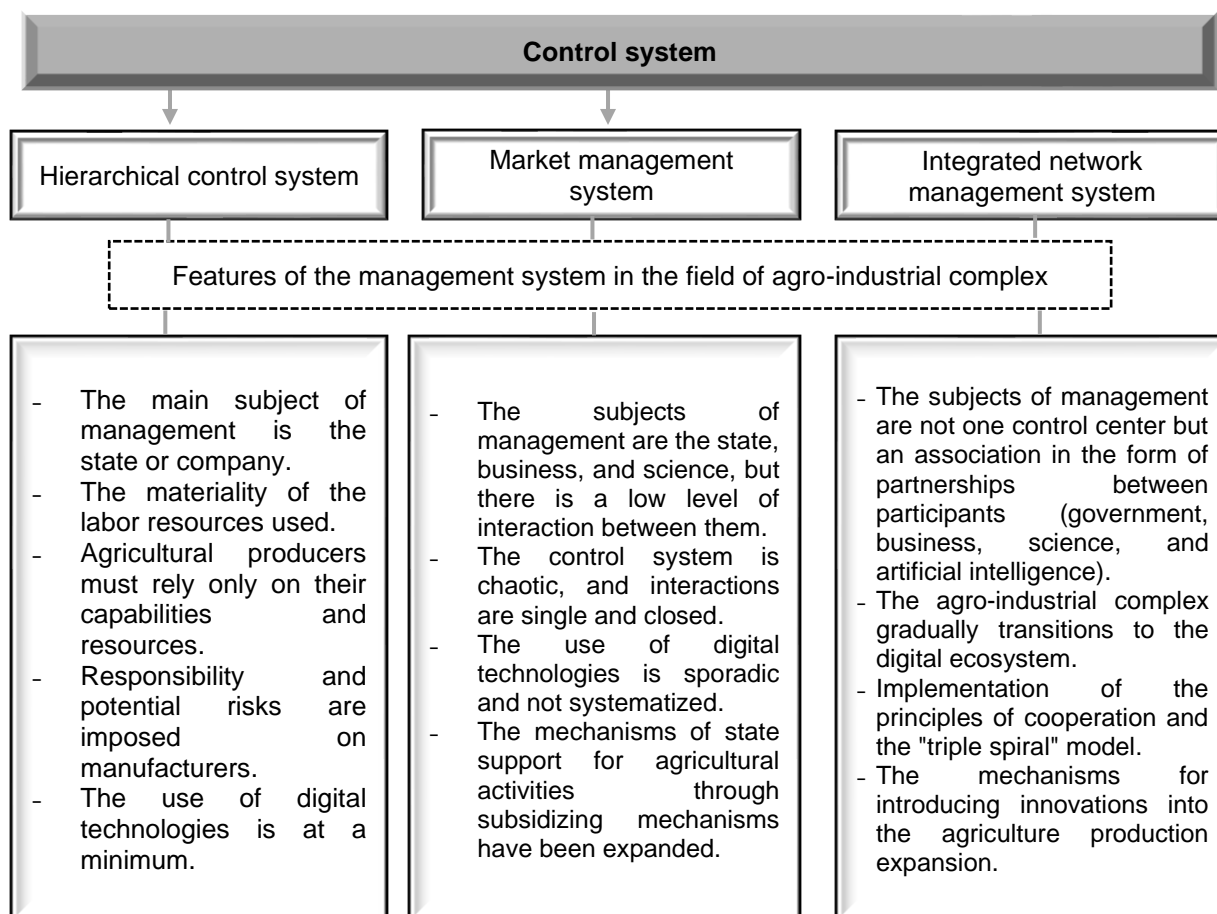


Figure 1. Evolutionary development of the management system in the field of the agro-industrial complex

2. *Market management system - based on the implementation of traditional laws of the market (market relations).* Compared with the hierarchical management system, this system is more flexible, but at the same time, certain restrictions remain. The subjects of the management system are expanding: representatives of business, government, and science. Market relations are expanding agricultural management tools, mechanisms for introducing innovations and digital technologies, and "partial automation" of managing production processes in the agro-industrial complex (AIC). For example, digitalized agricultural equipment, sensors, unmanned aerial vehicles, and other digital

elements are emerging. The possibility of detailed monitoring and control over yield indicators and other parameters affecting cost reduction and risk reduction confirmed the effectiveness of digital and modern technologies. Oborin M.S. notes that "in the transition to smart agriculture, humans will play a secondary role in tracking the current state of the natural environment. This function will be taken over by various sensors that will analyze the state of the components of the natural environment (air, soil, water), as well as automatically control lighting, irrigation, and fertilization" (Oborin M., 2019, p. 224).

The market form of management does not cope with the large flow of information

generated and transmitted through global economic networks and coordinating platforms, which requires the application of the principle of 'collaboration' teaching the activation of interactions and coordination of ties between cooperation participants who exchange knowledge and assets, unite when making decisions. (Alikaeva, Ksanayeva, & Prigoda, 2020)

3. *Integrated-network control system - emerging and applied in the conditions of building vertical links, the most flexible control system.* In our opinion, such a management system allows the creation of backbone agro-clusters built on the principle of 'collaboration', activating the processes of cooperation and knowledge exchange, technologies, and other resources between the main participants through cooperation and coordination.

In the field of the agro-industrial complex, a gradual transition to a digital ecosystem of agricultural management is being activated. That implies the creation of a single digital space for most participants in the production and the products (works, services) promotion. This management system involves expanding the areas of application of modern digital technologies and innovations, which in turn make it possible to develop or strengthen the existing competitive advantages of the industry. In the Russian Federation, the digital transformation of agriculture is a geopolitical and significant factor in the development of the agro-industrial complex, which is part of the spheres of national interests since the development of agriculture is a factor in ensuring the country's food security. Figure 2 schematically illustrates the mechanism of digital transformation of agriculture.

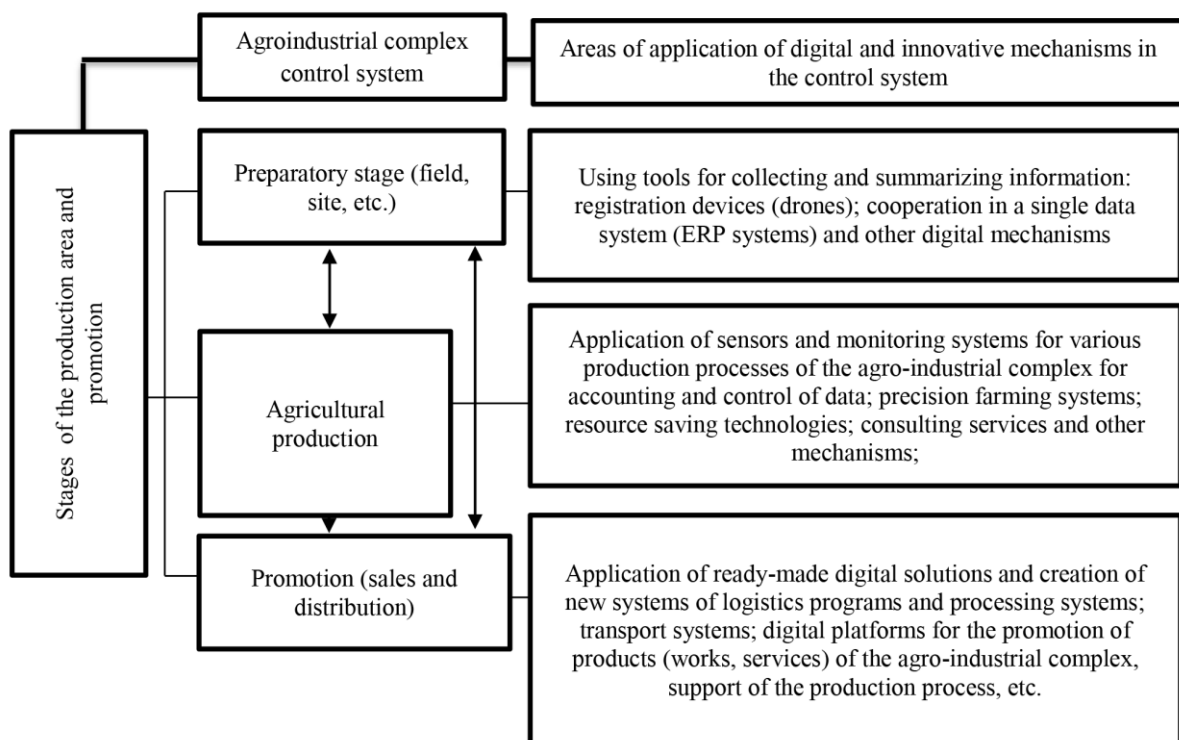


Figure 2. Mechanism of digital transformation of agriculture

Source (Shogentsukova & Shogentsukov, 2020)

The use of this mechanism for the digital transformation of agriculture should assume the presence of universal systems for managing the production process and the sale of products (works, services) of the agro-industrial complex, capable of covering a large amount of input data and their systematization, accumulation, and

analysis. The control system should allow the use of multivariate tools, be mobile, and be capable of adapting to the rapidly changing conditions of the functioning of agricultural entities. Also, a significant factor is the degree of coverage of all stages (stages) of the production process and the promotion of products (works, services).

Practical experience shows that the basic model of digital transformation of agriculture should be modified considering the complex problems of the agro-industrial complex. The solution to this problem is possible by weaving digital technologies into the management system of the country's agro-industrial complex, which can facilitate or create effective feedback tools between the major participants in the production cycle and marketing of agricultural products (works, services). In these conditions, the use of digital and innovative mechanisms allows the Control System to solve pinpoint problems of the agro-industrial complex. However, to increase the scale of the implementation of the digitalization process in agriculture, it is necessary to create conditions for the functioning of the agro-industrial complex management ecosystem (Shogentsukova & Shogentsukov, 2020). The need to create a single platform for approvals and expanding platforms for communication between participants in agricultural production and marketing creates conditions for a gradual transition and consideration of the agro-industrial complex as an ecosystem that requires the activation of the introduction of digital technologies and innovations without selectivity but with the maximum coverage of all processes. The degree of implementation of digital and modern technologies in the management system significantly impacts improving the efficiency and overall competitiveness of the industry. The ecosystem approach in agriculture, and the use of clustering, are tools of the general management system of the agro-industrial complex.

In our opinion, when forming the conceptual foundations for the modernization of agriculture, it is necessary to consider the agro-industrial complex (AIC) as an ecosystem, a system that unites into a single space not only participants in agricultural production and sales but also other structures: government agencies, business representatives and scientific community (universities, research centers). At the same time, the agro-industrial complex ecosystem is a self-developing system of functioning of various participants in a single environment (Shogentsukova & Shogentsukov, 2020). The application of the ecosystem approach in the

Russian economy, in particular in the agro-industrial complex, is, in our opinion, relevant, in the conditions of non-systematic and situational territorial and subject specialization, inconsistency, and non-systematic decisions at various levels of management.

The complexity of building a management system in Russia is the need to reduce the degree of 'complete' unification and gradual transition from total government in various industries, when the main subject of government is the state authorities, to a modified one that involves an expansion of government subjects. At the same time, an effective and efficient management model construction presupposes the formation of a system of not only 'partnership' relations but also the intensification of the participation of other government entities other than the state. Cooperation and interaction of the main institutional sectors will allow not only to accumulate and combine the opportunities and resources available to them but also to expand the mechanisms for the use of new modern technologies and innovations, including the digital transformation of the industry (agriculture). As noted by some authors (N.E. Bondarenko and T.P. Maksimova), "the intersection of three sectors (government, business, and science) is becoming a new mechanism for achieving consensus and a universal institutional matrix for innovative growth" (Bondarenko & Maksimova, 2016, p. 16), within this, each of the participants is a separate subject of the management system.

In our opinion, only in the context of the intensification of the use of 'scientific knowledge' in production activities in the agro-industrial complex, it is possible to apply the concept of a triple helix and transform the management system of agro-clusters from a traditional to a backbone and innovation system. At the same time, universities and research centers are crucial sources of scientific knowledge. Increasing the level of interaction between research centers, universities, and the state can help expand the university's capabilities in the implementation of scientific, intellectual, and other achievements obtained during research and design, and innovation activities. An innovative mechanism that arises because of cooperation, and not in the

form of individual demand or supply, significantly increases the efficiency of various categories of projects. The construction of the model (matrix) of the 'triple helix' is based on the concept of cooperation, not on the influence and control between the participants in this spiral. It is a cooperation that becomes the starting point for the development.

The widespread use of the collaboration mechanism contributes to the emergence and formation of a cluster-network management system in which various participants are united into a cluster, which occurs by combining resources, ideas, and general coordination of tactical and strategic development plans. The basis of the 'triple helix' matrix is the "evolutionary concept of technology development" that affects the processes of economic growth and the network connections used in the system. In parallel with these network connections use, the economic systems and the model of interaction between participants in the agro-industrial complex are changing.

According to several authors, "the main element of novelty in the innovation model of the triple helix is the strengthening of the role of the university" (Shogentsukova & Shogentsukov, 2020). In previous models, the emphasis was on the state or business. The most optimal option is considered a model in which the interaction of all three participants in the spiral is approximately equal in development. At the same time, there is a change in universities, a transition from a purely educational and scientific institution to an "entrepreneurial" one, i.e., innovative. Applying the "triple helix" model can ensure the country's agro-industrial complex (AIC) sustainability development. It presupposes integration, selection of technologies, and resources used in agriculture. State and regional authorities must ensure a level playing field, reaching a compromise of interests of all participants in the model: business, government, and universities. The intersection of interactions between the state and business is based on formal and informal ties. An increased degree of communication between the state and science is developing between scientific and educational organizations under the jurisdiction of the Ministry of Education and

Science of the Russian Federation. But at the same time, there is no general policy in innovative development.

3. RESULTS AND DISCUSSION

For the efficiency of the agro-cluster management system, it is necessary to take into account the trends of scientific and technological development, including the intensification of the use of modern and digital technologies, i.e. science-intensive technologies requiring the involvement and activation of the participation of representatives of the scientific community in the production of agricultural products (works, services). The use of high-tech technologies determines the innovativeness of the creation and functioning of clusters. The USA, Denmark, Finland, and China implemented that approach fully. The use of science-intensive technologies as the basis for the construction and management of clusters requires resources that developed and diversified economies can afford. On the other hand, it becomes possible to create or enhance competitive advantages and investment attractiveness of both the main participants and the industry as a whole. Building a rational management system for backbone innovative agro-clusters can become a multiplier effect on the development of agriculture both in individual regions and in the country.

Cluster management in Russia predominantly involves the active participation of the state, but at the same time, to increase the efficiency of the cluster, it becomes necessary to expand the participants in this process. The presence of representatives of government, business, and the scientific community allows for balancing control over the use of resources while respecting the interests of all participants. The use of the "triple helix" model in the formation of backbone innovation clusters implies "triple coordination determines the performance by the participants of previously uncharacteristic functions, the traditional function of business is the introduction of innovations, the university is in the production of knowledge and technology, the state is the establishment and regulation of the relations of the participants" (Kozlov, 2016).

The application of the triple helix concept modifies the role of the main subjects of governance: the state becomes a public entrepreneur or “venture capitalist” willing to invest in startups; research centers and universities are stepping up their participation in entrepreneurial activity; the private sector, i.e., business is involved in educational and research activities, which in turn can significantly expand the mechanisms for

increasing the efficiency of the industry development both at the macro, meso, and micro levels. A significant factor in agro-industrial clusters in the Russian Federation is the need to consider territorial differentiation, i.e., the allocation of areas of advanced development for the production and processing of agricultural products.

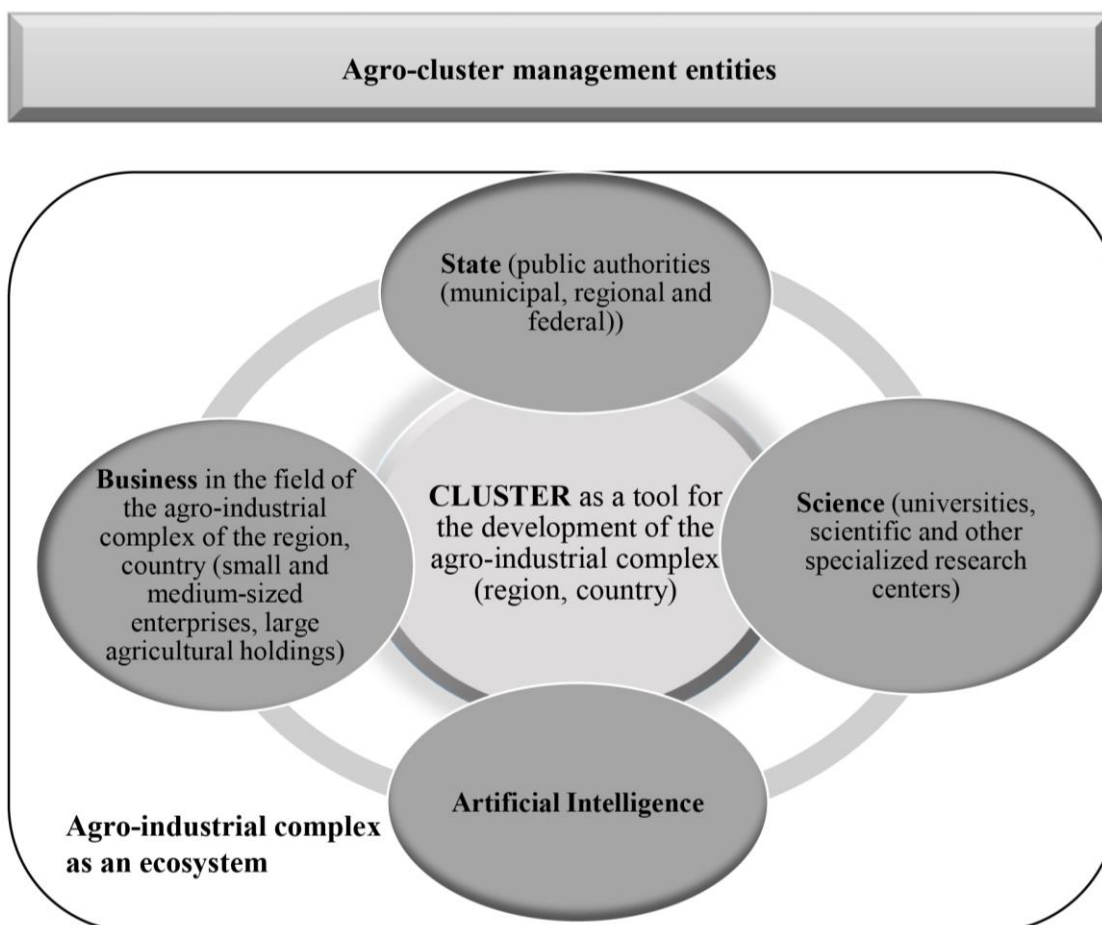


Figure 3. Subjects of the cluster model of the agro-cluster management system (region, country)

Source: (Oborin, Alikeeva, Shogentsukova, & Shogentsukov, 2022)

Clusters act as a tool for the development of the agro-industrial complex, uniting not only various forms of management, ranging from farmers and small farms to medium and large agricultural holdings but also creating a single space where the subjects are representatives of various institutional spheres (see Fig. 3).

In addition to those highlighted in Fig. 3. participants in the "triple helix" model, a significant element is artificial intelligence. The implementation of the cluster approach in the agro-industrial complex at the level of individual constituent entities of the Russian Federation can

become a catalyst for the development of the region, as well as a multiplier for the application of the obtained positive trends not only in agriculture, but also in related sectors of the national economy: transport, light and food industries, mechanical engineering, and the chemical industry.

In the modernization of agriculture, a significant element is the intensification of the use of artificial intelligence as a technology for improving the management system of agro-clusters. At the same time, this technology is used in various directions and stages of production activity: from

identification of agricultural raw materials to production and processing, ensuring the effectiveness of promoting agricultural products. With the help of artificial intelligence in the agro-industrial complex, it becomes possible to intensify the processes of digital transformation of agriculture, which is especially important in the context of the need to reduce the dependence of the production process on the climatic, seasonal, and other sectoral features of agriculture. Climate forecasting, simulation, and the creation of special conditions necessary to achieve the efficiency of production technology and the promotion of agricultural products are possible with the use of artificial intelligence technologies, which in turn can become a competitive advantage for the industry as a whole. The result of the use of these technologies, on the one hand, is an increase in labor productivity, but on the other hand, there is a demand for highly productive personnel (there is an expansion of human capabilities in the workplace; the emergence of new professions), which universities and research centers can provide the market with. These difficulties can be solved at the level of functioning of agro-clusters and cooperation between the main participants.

Integration and global processes, as well as the intensification of digitalization of the economy,

including agriculture, require mobility from the management system. Lagging behind advanced technologies is becoming a threat not only for individual countries, businesses, and the scientific community but for all systems of socioeconomic and legal relations and the world economy.

The objects of management of agro-clusters (see Fig. 4) are the resources necessary for agricultural production activities, which include three stages: preparatory, production (processing), transportation, and promotion of agricultural products. When building a management system in the field of agriculture, it is necessary to take into account the following factors that are specific features of the industry: the crucial means of production is land, i.e., the need for a territorial production basis; territorial dispersion of production, remoteness of subdivisions from the control center; significant dependence on natural and climatic conditions and with other related sectors of the national economy, etc. Reducing dependence on these factors is one of the main goals of agricultural modernization, which can be achieved using specialized production mechanisms, modern new approaches, and other innovations, for example, the creation of a special environment - a greenhouse.

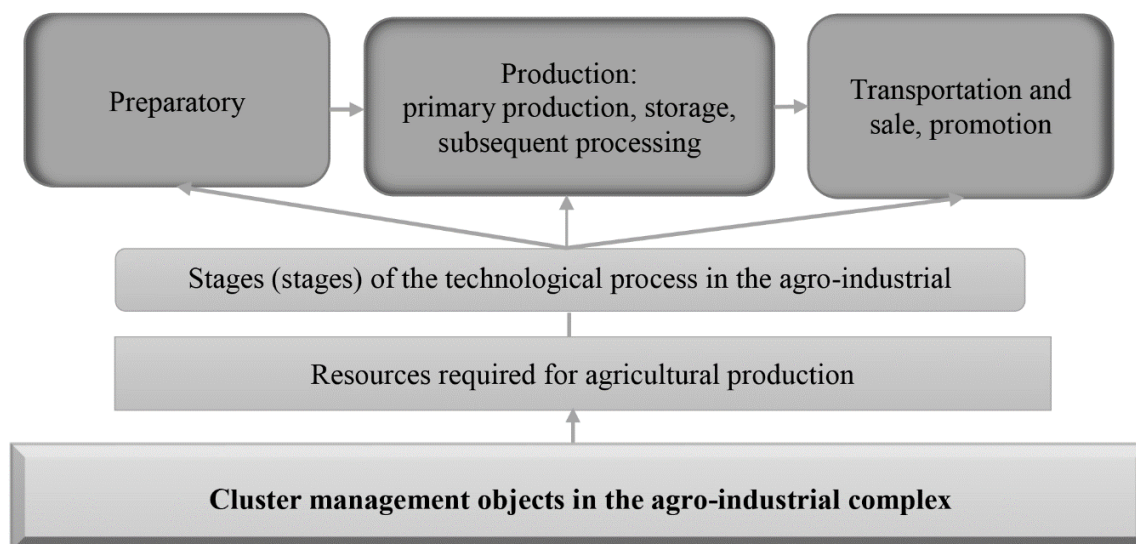


Figure 4. *Objects of the cluster model of the agro-cluster management system (region, country)*
 Source: (Oborin, Alikaeva, Shogentsukova, & Shogentsukov, 2022)

A significant factor in the development of the agro-industrial complex is its transformation into an ecosystem that involves not only the activation of

the use of modern technologies and the digital transformation of agriculture but also expanding other mechanisms for the development of the

management system. The creation and application of agro-industrial clusters (agro-clusters) as backbone innovative management tools in the field of agriculture, in our opinion, should be considered as an innovation project aimed at developing the industry not only at the country level but also at the level of individual subjects (regions) of the Russian Federation. The functioning of the agro-cluster provides for the activation of the achievements of scientific and technological revolution, and the formation of a specialized infrastructure that ensures the coordination and adoption of various categories of organizational and managerial decisions by the main subjects of the management system. The intensification of the application of science "influenced the creation and functioning of an integrated information system for enterprise management, providing managers with the data necessary for planning, monitoring, evaluating business operations, making management decisions" (Shidov, Gedgafova, Kazieva, Sizhazheva, & Shogentsukova, 2019, p. 237)

The effectiveness of the application of the concept of 'triple helix' in the agro-industrial complex can be considered from the standpoint of a separate region since "obvious features of agro-industrial clusters are observed at the meso level of individual regions" (Bondarenko & Maksimova, 2016). We think building an effective and efficient management system in the agro-industrial complex is possible using the triple helix concept. The subjects of management are government bodies that ensure the implementation of the strategic goals of the country's economic development; representatives of scientific centers and universities, whose activities are aimed at enhancing the implementation of scientific and technological development achievements in the national economy and the commercialization of their developments; representatives of the business community.

The use of the cluster approach to building a strategy for the development of individual regions of the Russian Federation in the field of agriculture acts as a catalyst for the overall development of the economy of the Russian Federation. The stimulus for the agro-industrial complex development is food security for the population provision, which serves as the basis for the

economic and scientific-technical development (STD) of the country and region. It also determines the welfare and health of the population. In these conditions, the main factor is the combination of state policy in the field of agro-industrial complex development by including it in priority national projects on the one hand and enhancing participation in the management system as subjects of business and science, which will modernize the entire industry and accelerate the implementation of effective mechanisms and achievements scientific and technological development into production activities. The expansion of the subjects of management makes it possible to form a different (new) system of economic thinking, carried out through the exchange of knowledge and technologies that can increase the efficiency of both the production of agricultural products and reduce the dependence on industry characteristics (natural and climatic conditions, seasonality of production, etc.).

Implementing the cluster model of the agro-cluster management system makes it possible to transform the general policy of the economy - a gradual transformation into an innovative system corresponding to international trends, activating the development trends of small and medium-sized businesses, and ensuring the use of high-performance technologies. The result of the implementation of the cluster management model in the agro-industrial complex should be an improvement of approaches to the regional development of agriculture; the creation of favorable conditions for a graded approach in the formation of a policy for the development of rural areas; the creation of new high-tech jobs, involving the intensification of the use of modern and digital technologies; taking into account the factors of import substitution and food security, etc. In addition, a specific infrastructure is being created. It makes it possible a single platform creation. A wide range of agricultural production and product sales participants can access the platform.

4. CONCLUSIONS

In our opinion, the study of the construction of the mechanism of digital transformation of agriculture, as well as the systematization of approaches and factors influencing the construction of the agro-

cluster management system in the conditions of digitalization allows us to highlight the following conclusions:

- The evolution of building a management system has historical prerequisites and factors that determine the directions that are relevant in the context of building a "new" management model in the field of the agro-industrial complex.
- Building or updating a functioning agro-cluster management system based on the "triple helix" concept allows accumulating the efforts of the major participants (by expanding them and involving science and business), to reduce the uncertainty in the agro-industrial complex and the costs of production and overproduction of agricultural products.
- The use of artificial intelligence technology in improving the management system of agro-clusters contributes to the formation of competitive advantages for the industry as a whole. On the other hand, it enhances the coordination of interaction between participants at various stages of the technology of production and sale of agricultural products (works, services); as well as directions for the development of the agro-industrial complex.
- Optimization and variation of various combinations of the use of resources of the main participants in the management system when applying the concept of the "triple helix" (science, government, and business), contributes to and affects the efficiency of agricultural production. Moreover, this influence can be both the renewal of the applied technologies and the basis for the creation of an entirely new product, using new technologies, for example, greenhouse production in vegetable growing, the use of digital technologies in breeding, etc. Combinations and different combinations of resources, production scales, and scientific potential can significantly increase the efficiency of the production process in the agro-industrial complex. This process can be different and individual for the implementation of a specific project in the industry at the level of the region or the country.

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ALLEVIATING POVERTY THROUGH ENTREPRENEURSHIP: HOMO ENTREPRENEUR, ENTREPRENEURIAL CULTURE, AND STATE

Mario Bogdanovic

University of Applied Sciences in Pula, Pula, Croatia
<https://orcid.org/0000-0003-3049-5342>

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*A better/richer economy and society requires better people and systems
in a moral (value), emotional, intellectual, and creative sense.*
(Author)

Abstract

Creating economic well-being considers entrepreneurship as a basic factor. Improving entrepreneurship improves economic well-being/wealth at all levels of aggregation: individual, family, social community, state, and world civilization. Improving entrepreneurship means applying knowledge and understanding its causal factors. It is essentially a psychological, socio-cultural, and political-economic phenomenon. As a psychological/mental phenomenon, it can be recognized in individual conative (value), emotional-motivational, intellectual, and behavioral characteristics of people who start businesses (characteristics of enterprising persons/homo entrepreneur). As a social/cultural phenomenon, entrepreneurship recognizes social attitudes and behavior (culture), manifested as a mentality as a key success ingredient. As a political-economic phenomenon, it recognizes the importance of the political-economic situation, that is, in the actual resource support of state institutions, the absence of obstacles/disincentives for entrepreneurs, and in economic policies, practices, and habits that stimulate entrepreneurial ventures and economic growth. The results of the discussion about the individual, socio-cultural, and political-economic characteristics necessary for an entrepreneurial (creative) society have several outcomes. In the context of poverty alleviation, there is indicated the necessity of cultivating/internalizing: a) specific characteristics of entrepreneurs that make up an entrepreneurial person/homo entrepreneur, b) specific entrepreneurial values - cultural characteristics that form an entrepreneurial culture/mentality, and c) specific political-economic entrepreneurship prone characteristics/behavior of the state (state institutions) that form an entrepreneurial state. In such a context, management solutions for entrepreneurial/economic development improvement should suggest an integral strategy for poverty alleviation. Such a strategy should have different levels of aggregation from the individual to the global civilization of the human species.

Address of the author:

Mario Bogdanović

[✉ mbogdan2011@gmail.com](mailto:mbogdan2011@gmail.com)



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1 INTRODUCTION

Overcoming poverty/scarcity in any form (material, mental) can only happen through wealth. Wealth is not only a natural creation (so-called natural wealth). It is human creation dominantly. It is easier to create wealth in an environment rich in natural resources (water, energy, suitable climate, fertile soil, food from nature, e.g., the ocean) than in an environment poor in natural resources. Areas with scarce natural resources and extreme climates (e.g., extreme heat, extreme cold) unsuitable for human life are traditionally economically underdeveloped (Landes, 2003). Therefore, in human society, wealth is a synergy product of intangible resources (ideas, knowledge, work, organization, and support of institutions) and tangible/material resources (existing natural resources and created capital in the past, e.g., accumulation of material, financial, and human capital). J. B. Say noticed this in 1803 in his work "Treatise on Political Economy". He singled out entrepreneurship (as a source of entrepreneurial profit) as the fourth factor of production, i.e., wealth (Buble & Kružić, 2006, 3 according to Jean-Baptiste Say, 1803 according to Lippincott, Grambo & Co., 1855). The purposeful initiation and development of business-oriented to profit live the essence of entrepreneurship (Dollinger, 1995 according to Cole, 1959). In the context of poverty alleviation, it is a key tool that characterizes the ability to make successful entrepreneurial decisions when there is no appropriate decision model or rule or when incomplete or unavailable data are required (Casson, 1990). At the same time, the so-called entrepreneurial spirit, which is the intention for human progress, development, changes, and achievements, empowers and motivates people, organizations, and societies. Entrepreneurship can fundamentally improve human lives in the context of achieving the desired material and socio-psychological well-being.

The most significant knowledge of economic history has not substantially changed from Adam Smith and his classic work *The Wealth of Nations* (1776). David Landes (1999, 2003) tells us that in poverty reduction, i.e., creating wealth, the factor of humans is crucial. So, we should never give up.

There are no miracle-working and shortcut solutions. There is no perfection, neither a golden nor an apocalyptic economic age. Attitudes should be constantly re-examined, avoid dogmas, listen carefully, and observe, explain, and define goals to better choose the means to achieve wealth and well-being (Landes, 1999, 524). For economic and business progress it is *necessary the existence of people who are against reason!* (George Bernard Shaw's remark). Namely, the prudent people adapt to the world - therefore also to the things which are essentially backward/primitive/anti-modern), and such unreasonable/crazy people do not give up in attempts to adapt the world to themselves (Handy, 1998, 4-5). Steve Jobs similarly stated in his famous (iconic) oration: *The people who are crazy enough to think they can change the world, are the ones who do.* (Brokop, 2013).

The assumption of wealth is, therefore, human capital, i.e., creative ability (inventive - innovative ability), the desire/will/motivation to create wealth/economic progress, and the mental and educational state of their creators (because the human mind primarily creates wealth/money). Therefore, if there is no creative ability, motivation, idea (idea about how to make wealth/money), knowledge of how to do it, knowledge of aggravating circumstances (unsupportive environment/unfavorable circumstances) economic/entrepreneurial idea have no chance to be materialized/monetized. Wealth essentially requires a certain mindset, a long-term way of thinking (Dollinger, 2008 according to Allen 2006), and the so-called entrepreneurial mindset, which can be educated informally or formally. A wealth-creating economy (the so-called "wealth-creating machine") requires the patient accumulation of surplus value (savings) and its meaningful investment in innovative products and services, to produce/create a constant flow of money (income). Therefore, wealth should primarily be created through the creation (production) of new products and services (Hutzinger, 2021), which is the task of entrepreneurship and innovation, and secondarily redistribute the created wealth (to alleviate the poverty of poor people and communities) according to some of the distribution

principle.¹At the same time, entrepreneurship represents knowledge/skills on products and services creation for the market, and innovation is knowledge/skills in the process of commercializing an invention (new product/service).

From the entrepreneurship perspective, the problem of poverty is that poor organizations and people (regardless of the appearance and level of aggregation, e.g., state, enterprise, family) do not find a way out of poverty creatively (Sutter, Brutton & Chen, 2019). Creative way means the creation of so-called active income (according to entrepreneurship and innovation modus) but in other modus of income, such as wage labor (as a rule, the poor people work long and hard as a workforce for low wages, so this is not an optimal way to overcome their poverty and poverty of their families). Other wealth-collecting methods that do not concern the creation of new values, but the redistribution of existing values often uses rent-seeking policy, games of chance, war as a profit maker, and crime/illegal/amoral activities. Sometimes neutral creative passive solutions without regard to the new value creation, e.g., already created assets for the collection of so-called passive income, e.g., rent on a property, rent on authorship, natural rent, or similar on rent-based income.

Entrepreneurship is the result of the interweaving of social, cultural, ideological, religious, ethnic, institutional, and psychological relationships (Bogdanović & Cakić 2017; Bogdanović, 2016; Bogdanović & Svržnjak, 2008). Personal theories of entrepreneurship are the sources of such an approach. It should consider at least three variables:

1. *Entrepreneur*, i.e., *entrepreneurial person/homo entrepreneur* in their psychological characteristics essential for entrepreneurship,

2. *Culture*: Entrepreneurial culture/entrepreneurial cultural climate is a way of thinking, believing, and behaving in society toward entrepreneurship and entrepreneurs in positive, neutral, and negative ways. Namely, each society has a specific cultural climate and “entrepreneurship mentality”.
3. *State*: An *entrepreneurial state* is an organizational form of society and a political-economic entity that gives or does not give adequate institutional support to entrepreneurs and entrepreneurship in general with a specific relationship towards economic growth.

This paper substantively deals with the explication of these three synergistic substances in the context of understanding the factors that influence entrepreneurial success (the success of an entrepreneurial venture) concerning poverty alleviation through wealth creation. In the context of supporting and stimulating entrepreneurship, the ultimate socio-economic goal is a stimulating entrepreneurial environment (culture, state), which, in addition to the psychological characteristics of a homo entrepreneur, is a significant factor in achieving wealth. Therefore, it has a high potential to alleviate poverty.

This paper aims to answer the question of how to meaningfully understand and manage entrepreneurship factors to achieve economic development, i.e., create wealth and thus reduce poverty. Factors that make up the basic structure of the paper are:

- a. *Psychological factors of entrepreneurship* that create homo entrepreneurial personality, so are potential factors of wealth creation (personality traits, abilities, entrepreneurial knowledge and skills, psychological capital, entrepreneurial talent/intuition), the so-called “psychological resources” of the entrepreneur/homo entrepreneur.

¹Poverty alleviation is impossible without economic development, i.e., entrepreneurship and innovation activity, but also it can help adequate distribution theory and practice. It can exist in very wealthy societies because of distribution (a small number of extremely rich and a huge number of extremely poor people) (United Nations Development Program Bureau for Development Policy, 2011). Distributive principles primarily depend on the ideology of justice, e.g., primitive/advanced form of communist justice, positional/distributive justice, exchange/commutative

justice, labor justice, solidarity justice, capitalist justice, social Darwinism justice (Visković, 1981, 147), procedural, compensatory justice (Bowles & Edwards, 1991) are out of broad explication and discussion here. A conclusion about this topic is that no one society has yet solved the problem of adequate (optimal) distribution because of very different ideologies of distribution. There is a need for a universal distribution ideology.

- b. *Cultural factors of entrepreneurship* are potential factors of wealth creation (a series of social/ethical characteristics that can stimulate or discourage entrepreneurial activity), and are elaborated as cultural factors of socioeconomic orientation, education, institutions, and culture/ethics of work, learning, and love which create actual cultural climate towards entrepreneurship/entrepreneurs.
- c. *Political and economic factors of entrepreneurship as potential factors of wealth creation.* These factors provide legal, financial, and political support. They manifest state policy and reflect the behavior of institutions towards entrepreneurs. This factor is unavoidable in entrepreneurial and socioeconomic development, and thus in reducing poverty.

The combined action of the three potential factors (entrepreneurial people/home entrepreneurial, entrepreneurial culture/cultural climate/ethics, and entrepreneurial state/society) of wealth, are prerequisites for a better economy and a better society with less poverty. The next sections discuss key elements of wealth creation through entrepreneurship.

2 ENTREPRENEURIAL PERSON/HOMO ENTREPRENEUR

A human being is a blessed economic resource because only humans create new/surplus value. Perhaps, artificial beings/artificial intelligence (AI) could do the same in the future. We can state that because material assets (financial and material/physical tangible resources), although considered the most significant entrepreneurship factor for wealth creation, they are not enough. Humans (human abilities in combination with human work) create wealth. At the same time, human beings can be a limiting factor of entrepreneurial investment, the possibility of competition, profitability, growth, and development of an entrepreneurial venture, if they do not have the necessary entrepreneurial qualities or specific characteristics needed for wealth creation. Without an entrepreneur (capable and motivated) neither surplus value nor capital can grow.

Psychological factors of entrepreneurship refer to the resources found in the entrepreneur himself

because, without entrepreneurs and entrepreneurial qualities in the physical person (human entrepreneur/homo entrepreneur), there is not, and cannot be any entrepreneurial activity. Through education, every society tries to socialize and train its population in numerous life roles, one of which also should be the entrepreneurial-innovative (creative) social role. The result of socialization in the direction of growth and development of entrepreneurial potential is enough quality entrepreneurs (capable and motivated). A successful entrepreneur (capable and motivated) is a scarce resource. According to Small Business Administration in the USA, (2023) only 0.4% of Native Americans are owners of an enterprise (Apolotechnical, 2023). A capable entrepreneur in this context refers to intelligence (cognitive and emotional), specific personality traits, and specific entrepreneurial knowledge and skills. A motivated entrepreneur in this context represents his willingness, as a leader, to contribute significantly to the realization of an entrepreneurial venture in the form of a one-time project (according to the project approach) or management of a newly founded company (according to the process approach). For the creation of wealth through entrepreneurship, the so-called psychological resources of entrepreneurs are crucial:

- a. *Intelligence, reason, cognitive mental abilities.* A few studies on the connection between intelligence (cognitive abilities) and entrepreneurship findings are significant. It was determined that *perceptive speed and calculation ability* are important for the entrepreneurial personality type (Kanfer, Ackerman & Heggstad, 1996; Ackerman, Kanfer & Goff, 1995), *average general intellectual ability* (Krapić, Kardum & Krištofić, 2008), *entrepreneurial talent* (Cingula & Veselica, 2010), *ability to use other people's knowledge* (Vukotić, 2015), i.e., which is the area of using specific knowledge management (North & Kumta, 2014). For entrepreneurship, personality traits proved to be more important than intelligence (cognitive ability).
- b. *Personality traits determine the values and motivational qualities of the entrepreneur.* Motives, desires, behaviors, and efforts of successful entrepreneurs are different from

other individuals, namely, people differ from each other in their entrepreneurial capacities, and researchers believe that the source of this is a specific entrepreneurial personality (Bogdanović & Cakić, 2017; Markman & Baron, 2003; Holland, 1997). In that research field, researchers investigate the main five personality traits and their connection with entrepreneurial personality. From the research, with high certainty is clear that the most significant trait for entrepreneurship is *extraversion* (dominant, optimistic, adventurous, vital, seeking pleasure, ambitious, self-confident, social, and popular people, so entrepreneurial professions strongly attract extroverted people (Costa, McCrae & Holland, 1984). *Neuroticism* (timid, sad, anger, and hostile, sensitivity to negative feedback, hopelessness, discouraged people by small failures, sensitivity to stress and anxiety) is not positively related to entrepreneurship because people with such traits do not cope well with business pressures as which are high workload, making critical decisions, uncertainty, and financial difficulties (Shane & Nickoleau, 2013).

According to Roccas, Sagiv, Schwartz & Knafo, (2002) discovered correlations between psychological traits and entrepreneurship: openness to new experiences (a positive and neutral connection), agreeableness (both a positive and a negative), conscientiousness (contradictory results), although they are individually interesting. The stated findings are inconsistent because they were either negative or positive, either contradictory related to entrepreneurship (in one part of entrepreneurial activities they encourage, and in another part of entrepreneurial activities inhibit entrepreneurship, e.g., the trait of conscientiousness).

- c. *Psychological capital characterizes emotional intelligence in the sense of mastering the personal emotions and motivation of the entrepreneur (Newman, Ucbasaran, Zhu & Hirst, 2014).* Psychological capital is a newer concept of the resource-oriented theory of the enterprise. It explains the sources of sustainable competitive advantage in the strategic human capital resource while emphasizing psychological capital, i.e., self-

efficacy assessment, optimism, hope, and resistance to stress/failure. It is established that it positively relates to entrepreneurship and the success of new business ventures (Leonard, 2016; Newman, Ucbasaran, Zhu & Hirst, 2014). In addition to personality traits, the psychological, i.e., motivational resource of entrepreneurship is significant, and it is similar to some contents in the concept of emotional intelligence in terms of the ability to solve personal emotional-motivational problems, i.e., *self-motivation, dealing with frustrations and other people emotions* (Levi, 2014).

- d. *Internalized values and attitudes are also often called "mindset".* Socialization and the influence of the environment can also have a significant role in the development of entrepreneurial "spirit" and entrepreneurial activity (Bogdanović, 2012). That is evident from experience and research, e.g., the entrepreneurial spirit (as a cultural trait) is more prevalent in the USA than in transition Balkan countries (Repić & Crisonino, 2015). The empirical data of individual entrepreneurship researchers assume that internalized awareness of the difficulty of living and earning is significant for the development of the entrepreneurial spirit (Pihie & Bagheri, 2013) and that entrepreneurship is a reaction to difficult living conditions, the so-called *the energy of suffering, trouble, and scarcity, the energy that is needed for survival* (Vukotić, 2015). It is an interesting fact that may support the hypothesis that in the USA in 2017, 17% of business owners were immigrants, and in 2023, 0.4% of Native Americans and 17.7% of minorities (Apolotechnical, 2023). For the development of entrepreneurship, a stimulating environment, a kind of specific socialization, which encourages people to take responsibility, makes them independent, and motivates them to undertake entrepreneurial ventures, is essential. A tendency to laziness and easy living would therefore be as unprosperous socialization and value-motivational characteristics detrimental to entrepreneurship. It is significant to note that *ambition* and *persistence* should adorn every entrepreneur.
- e. *Intuition and undefined innate entrepreneurial talent.* Some authors also mention an

entrepreneurial feeling, an intuition, a tendency that could be classified as a specific entrepreneurial talent, which is innate as well as an artistic tendency, which one cannot learn, just as "innovation and excellent new product creating cannot be learned" (Cingula & Veselica, 2010). Namely, such individuals (judging by anecdotal entrepreneurial stories) already from the earliest age (primary school), have "entrepreneurial feeling", and start their small businesses (even in environments not inclined to entrepreneurship), e.g., selling agricultural and other products, trying to benefit from their business activities (Frlan, 2010), they have an "innate" inclination to business and earning. Although there are literary and anecdotal reports and personal experiences about it, as far as the author knows, there is no systematic research on this intuitive and innate aspect of entrepreneurship.

- f. *Specific entrepreneurial knowledge and skills.* Also, a significant psychological factor of entrepreneurship is the *knowledge and skills* that an entrepreneur must be successful in his job (Cingula & Veselica, 2010). They are internalized through formal, informal, schooling, and practice. Learning about entrepreneurship also has a significant role in creating an "*entrepreneurial spirit*" and culturally trains the young generation to think entrepreneurially and so ensure future existence, e.g., with linear (from wage labor) and residual income (from past work and entrepreneurial work).

For the success of entrepreneurship, psychological resources (resources of the entrepreneur) are therefore at least as important as financial ones because the entrepreneurial character has a key influence on entrepreneurial decisions and behaviors (Logohere, Callot, Gallopel & Peters, 2004).

The base entrepreneurial motivation of an entrepreneur is not only psychological but also material. To enter the world of entrepreneurship it is significant to have the perception that an entrepreneur can make a good living from entrepreneurship and stay in that business and experience entrepreneurial success (Robichaud, McGraw & Roger, 2021; Kuratko & Horsley, 1997). Economic freedom with low entrepreneurial costs

here is essential. Therefore, "entrepreneurial spirit/mindset", entrepreneurial intuition, entrepreneurial personality traits with some specific entrepreneurial knowledge, and a feeling of economic freedom are essential entrepreneurial factors. Together they condition entrepreneurial motivation. The perception of the possibility of earning/living from entrepreneurship (the so-called feeling of good chances of success) is important for the entrepreneurial motivation (entering the entrepreneurial world), where the following are significant:

- a. Characteristics of the entrepreneur's personality
- b. Entrepreneur's abilities. In addition to mental abilities, physical abilities, and vitality can be included, which manifest as life and work energy.
- c. Entrepreneurial knowledge and skills

discuss these entrepreneurial traits in more detail below.

2.1 Entrepreneurial Personality and Entrepreneurial Interests

There exists an entrepreneurial type of personality, that is the personalities that distinguish entrepreneurs from non-entrepreneurs. According to Holland's theory (1997), entrepreneurial personality has higher results on the:

- Internal locus (place) of control.
- Goal orientation.
- Creativity.
- Tendency to risk.
- Need for achievement.
- Marketing abilities and sales skills (designing and furnishing products for sale, defining appropriate prices, promotion, selection, and organization of the selling spots, and operational implementation of sales of goods and services to other people, after-sales services).

Research has shown important relationships between five (N=5) key personality traits for entrepreneurial success (Kerr, Kerr & Xu, 2018). So, the general description of entrepreneurial personality says that entrepreneurs have a high level of conscientiousness, emotional stability, extroversion, assertiveness, and "hard intention" (Lounsbury, Smith, Levy, Leong & Gibson, 2009).

So, all of the top 5 personality traits (extraversion, neuroticism, openness to experience, agreeableness, and conscientiousness) are to be somehow related and predict success in entrepreneurship (either positively, neutrally, or negatively). Extraversion relates to entrepreneurial interests (DeFruyt & Mervielde, 1999; Barrick & Mount, 1991), and neuroticism is significantly negatively related.

Agreeableness as a personality trait is controversially related to success in entrepreneurship and seems to be dependent on the cultural milieu (some studies of Western provenance indicate a negative correlation, and from the area of Sudan, Africa (Baluku, Kikoma & Grace, 2016) a positive correlation, which requires additional research). Research on a Croatian sample showed that personality traits predict as much as 26% of the variance of entrepreneurial interests, where extraversion proved to be dominant (Krapić, Kardum & Krištofić, 2008). The same research shows that entrepreneurial types significantly overlap with personality, so entrepreneurial tendencies and interests can only be predicted using personality traits.

Entrepreneurial interests predict to a greater extent in comparison with personality traits, i.e., extraversion, and to a lesser extent by intelligence. Extroverts are social, assertive, active, strong, energetic, and adventurous (Kendra, 2023), and the desire to influence others and achieve organizational goals or economic rewards is their basic motivation, so they prefer social and entrepreneurial jobs that best ensure the satisfaction of their basic motives. Therefore, extroverts with behaviors focused on activity, strength, and adventure are more inclined to entrepreneurial jobs that require them to lead and convince people.

These findings point to the need for psychological testing (especially extraversion, which is positively related to entrepreneurial success, and neuroticism, which is negatively related to entrepreneurial success) (Awwad & Al-Asser, 2021) to support entrepreneurial training programs.

2.2 Entrepreneurial Abilities

Although rare studies provide data on the connection between intelligence and

entrepreneurial interests, their findings are quite consistent. Intelligence does not relate to entrepreneurial interest, and according to some researchers (Ackerman & Heggestad, 1997), negative correlations are between abilities and entrepreneurial interests, except for perceptual speed and calculation (Kanfer, Ackerman, Heggestad, 1996; Ackerman & Heggestad, 1997). Since the common feature of entrepreneurial jobs is their less demanding ability than jobs from e.g., research or realistic domains (e.g., engineering jobs, medical-veterinary jobs), it is more likely that entrepreneurship will be preferred more often by individuals with average abilities (Krapić, Kardum & Krištofić 2008). In this context, entrepreneurship should include individuals with average, and not very high intellectual abilities, because it is more likely that they will quickly get bored with entrepreneurship, because of the discrepancy in their intellectual capabilities. Namely, intelligence proved to be the most significant factor in predicting vocational choices and development. Therefore, entrepreneurship does not require above-average intellectual ability, but it undoubtedly requires entrepreneurial talent and creativity, which are largely innate (as well as artistic expression). Namely, systematically producing top quality in anything usually is not possible, but is regularly self-produced, which points to the innate nature of such traits.

Success in entrepreneurship requires combined psychological resources, which most likely represent a combination of not only abilities but also personality traits and interests. Although vitality (high work/emotional energy) is mentioned and measured in the context of personality traits and emotional intelligence (Simons & Simons, 2000), it is a physiological ability of the organism and is highly correlated with physical energy and health. Namely, it is known that some people are slow and indolent (have low work/emotional energy), while some people are fast and hyperactive (have high work/emotional energy), which is necessary for entrepreneurship (in literary terms, "entrepreneurship requires the energy of youth, hyperactivity!").

These findings point to the need for psychological testing, especially calculation ability and perceptual speed, as well as evaluations/assessments or tests of vitality/emotional energy as support for entrepreneurial training programs.

2.3 Entrepreneurial Knowledge and Skills

In addition to courage and willingness to take risks, extraversion, and natural talent, an entrepreneur's success is always the result of certain knowledge and skills. Although it is not easy to answer what kind of knowledge an entrepreneur needs, it should be diverse and comprehensive. An entrepreneur needs to have different knowledge and skills. Cingula & Veselica, 2010 mention different dimensions of entrepreneurial knowledge such as

- a. *economic*; In the economic dimension, an entrepreneur should:
 - know the market, especially the relationship between supply and demand for the products and services it offers.
 - know the financing mechanisms and costs of using someone else's property, regardless of whether it is permanent or temporary.
 - understand relations with suppliers and with his customers.
 - understand the behavior of the workers they will hire.
 - understand the behavior of people in the local community.
 - understand the behavior of people in state institutions.
 - know how to communicate with all stakeholders regardless of the size of his undertaking (diplomatic skills).

Acquisition of the knowledge and skills can be done formally or informally. Although it is perhaps easier to acquire formally (by formal organized study), today (2023), college degrees (formal education) in the USA seem to be less significant to entrepreneurs as regular employees (Apolotechnical, 2023). According to Guidant Financial, about 30% of entrepreneurs only finish high school, 31% have an associate degree, 17% have a bachelor's degree, 18% earned a master's degree, and 4% have a Ph.D. (Apolotechnical, 2023). Good formal education can help many career paths but seem not crucial for entrepreneurship. Without informal learning (entrepreneurial experience), and a very good high school, it is suggested that the formal education needed for an entrepreneur should

be at the level of a bachelor's degree. Supplementary schooling is needed either in informal education continuation or formally through seminars. They relate to specific business issues: business planning, business psychology, business finance and accounting, commercial/business law, use of computers in business, etc. Programs for developing entrepreneurial business intelligence, operationalizing entrepreneurial ideas, and the like are also possible.

- b. *managerial*; An entrepreneur (especially if he manages a micro or small business) has to perform a series of managerial jobs and tasks, so his knowledge does not differ from what a manager in a large company needs to know. These are, e.g., setting strategic goals, planning, and using resources, organizing jobs and tasks, selecting, and motivating associates, and controlling all business activities. Within this function, the entrepreneur should have the skills to form a network of business associates (suppliers, customers, and other stakeholders). Specific managerial knowledge (basic and mediation/integrating functions) can be acquired through formal studies (undergraduate, graduate, and postgraduate), but also through shorter programs for the development of specific competencies that an entrepreneur-manager should have.
- c. *innovative*; Inventive-innovative giftedness, although it is not possible to directly acquire through formal education, like entrepreneurial talent is innate to gifted individuals, it can be encouraged through education (upbringing and education) from childhood. For an entrepreneur in the age of the Internet (Yenchun, Shih-Chih & Chia-I, 2019) it is important to learn to innovatively recognize, store, and search for relevant information because this opens space for encouraging entrepreneurial innovation and new entrepreneurial activities and ventures.
- d. *ethical*; Entrepreneurship implies, at least, a minimum of business ethics and social responsibility. Some authors even think that business ethics is crucial, even more important than profit, for all businesspeople (Sikula, 1996). Therefore, even in the formal educational system teaching basic standards

of behavior that are acceptable in the socially responsible behavior of entrepreneurs and large corporations is obvious. State institutions and/or communities should also punish deviant and criminal business behavior, even socially unacceptable (socially harmful) behavior of individual socially irresponsible/ amoral/ anti-moral entrepreneurs. Future entrepreneurs are to obligate ethical business values and behavior.

Technical-technological, economic, and legal knowledge along with knowledge of business psychology, computer literacy, and business ethics are part of the processes of formal college education. After the completion of formal education, the entrepreneur can and should constantly work on improving himself (informally through seminars or self-taught learning) in all dimensions that make him a successful entrepreneur. The main entrepreneurial motivation stimulates the knowledge of monetization (quickly and profitably).

Summarizing all these findings can be concluded that diverse psychological resources are key factors of entrepreneurship, and they are essential in creating wealth i.e., poverty alleviation.

3 ENTREPRENEURIAL CULTURE

Modern political, social, and economic problems cannot be isolated from values, so the nation's vitality is primarily the value problem (Landes, 2003 according to Clesse). Social values are extremely important for entrepreneurship and wealth creation (Bogdanović, 2012; Bogdanović, 2011), and therefore also for poverty alleviation. The selection of the economic system at the end depends on the sociological and political philosophy that decides on the selection of the dominant scale of values as the dominant moving force. Namely, the economic system depends on social and political philosophy that supports him

and decides about the dominant value system (Lukšić, 1995). Cultural values are key to human and economic life (Kulić, 2009). Without appropriate cultural values the nations are convicted to extinction (Kulić, 2011), and people and their cultural values depend on the functioning of the institutions which are basic for socioeconomic development (North, 2003). The values in general represent moral standards that tell people how they should feel (feeling component), what they should aim for (motivational component), and how they should behave (behavioral component). The values also show why people do certain things (synthesis of the purpose of action), and if those things are acceptable or unacceptable from some value-moral point of view, and the values are represented by the individuals, groups, organizations, societies (Bahtijarević-Šiber, Sikavica & Pološki-Vokić, 2008, 535), but also globally so we can talk about universal values.²

The economy participates in society's system of values and accepts the dominant code of values (Lukšić, 1995, 185). Therefore, identification and understanding of the basic elements of economic development include analysis and mobilization of modern political, social, and economic problems, which are inseparable from the values. Namely, the conclusion of the researchers about people's wealth/poverty is that since the age of Adam Smith (1776), there has been no new light on the above-mentioned problem, it is primarily in the culture (Landes, 2003) or in the defined system of values. Developed countries (e.g., Germany and Japan) realize that values (e.g.) reliability, punctuality, discipline) should be educated because they are crucial for economic growth (Jašić, 2000 according to Herzog).

According to Khandel & Mohendra (2010, 20), the values in this context can be viewed on the macro concept (the level of the society) or the micro

² Defined universal cultural values which are present in all cultures and all time periods are: wisdom and knowledge (curiosity, desire to learn, open mind and critical thinking, creativity), boldness (persistence-diligence, integrity-natural behavior-honesty/fairness, vitality-enjoying life-passion-enthusiasm), humanity (generosity, love for others and letting others love us, social/emotional and personal intelligence), justice with different contents: social responsibilities with sub elements (being a citizen, social responsibility without personal gain, loyalty, team work, craftsmanship);

honesty and morality; the ability of leadership as a part of character, moderation which contains: self-control and self regulation of someone's behavior, common sense (the ability to predict the consequence of our decisions) modesty/humbleness and forgiveness/charity) and transcendentalism (gratitude, hope and optimism, humor and playfulness, respect for beauty and excellence, spirituality/religion) (Bogdanović, 2013; Miljković & Rijevec, 2006).

concept (the level of the individual) even though the values can be studied on the mezzo level (the level of the organization and social groups of different sizes). Namely, it is practically impossible to speak about only one level of values because personal values (the micro level of values) are interwoven with the values of different social groups where there is, for example, business organization (the mezzo values) and national and universal values (the macro level of values). The psychologist stated that personal values are essential for human motivation because they determine the emotional-motivational orientation and mediate the ways of living and working (Pastuović, 1999.). Landes (2003 according to Clesse, 12) pay special attention to the difference between different people/culture regarding wealth or poverty. He concludes that such differences in wealth is primarily the differences in their values. The differences in the economic development of societies (nations) are in the specific characteristics of these societies in cultural, value, and institutional sense (Bogdanović, 2011, 68). Cultural characteristics of individual societies come from the way of life of their members, that is from the way of dealing with problems of life and living. The way of life and the corresponding socialization (upbringing) form socio-psychological characteristics of individuals and social groups that then form economic thought and systems. Therefore, socio-psychological characteristics formed that way (upbringing) are the crucial factor in economic development. Culture (and values) are the key to human and economic life (Kulić, 2009).

Namely, it is becoming clearer that the ethics of everyday behavior or the codex of behavior (e.g., rationality, diligence, take-charge attitude, honesty, seriousness, thriftiness, efficiency, patience, urgency, neatness, etc.) lead to economic success, and opposite characteristics to the economic failure. For economic development, the key element is the upbringing of people of certain characteristics. Also, the deciding factor of the economy and any other society's success is the quality of those who make and carry out decisions, so their value of socialization is very important from the economic point of view. The functioning of institutions is the basis of socioeconomic development beyond the organization and depends on people and their

system of values (North, 2003). According to the definition, upbringing is learning of motives, values, and interests, where the stronger component is will and attitudes whereas the stronger component is the emotional one. This is important because it determines the emotional-motivational direction, and it mediates the ways of life and work (Pastuović, 1999). E.g., for economic development, it is relevant what kind of "spirit" most people in a certain society were socialized (e.g., if the dominant philosophy was "Live to work" or the other way around "Work to live"). In the context of the formation of human capital, upbringing is the key factor for economic advancement and development. The key element of education and development is an orientation towards values (e.g., Germany and Japan) through which the virtues which have meaning for development e.g., reliability, punctuality, and discipline are mediated (Jašić, 2000, 199 according to Herzog). Then according to the dominant virtues of a certain society (internalization of certain important values is a part of human capital) we can predict well their economic success, wealth, or poverty (Landes, 2003). Ethics that internalize specific values and culture for economic development are the regulation system of human behavior in the sense of "the philosophy of desirability". To develop important economic characteristics of human capital (e.g., take charge attitude characterized by many economic initiatives) they need form and support by specific generally accepted cultural values. Values of prosperity (e.g., the sense of duty, responsibility for those beneath and above you, diligence, work, integrity, and similar) will guide society towards socially valuable aims (e.g., the production of quality goods and services) from social, economic, and political supporting institutions.

A personal initiative can be encouraged (e.g., supported enterprise, personal freedom, autonomy, individuality, and economic security) or discouraged (e.g., autocratic, oppressive, exploitative, arrogant, and rapacious behavior of the elite operational through the institutions). Different cultural climates form the government that tries to attract enterprise and its income from the climate formed by indifferent, arrogant, and rapacious (corruptive and based on rent).

Therefore, the first step for economic development is to set and internalize the primary social goal of economic prosperity with the help of its own (national) forces (so from within and relying on itself). That is a value category (Bogdanović, 2012). If that is the goal, to achieve it we need to form people of certain characteristics (raise and educate), and if, at the beginning, that is not enough, we should attract such people with different benefits. While doing that the basic principle of every rational economic development is that it is desirable to build the society and its economy on the culture of work and creation, and not on the culture of plunder, rip-off, and demanding of rent (redistribution). This fragment concludes that economic development is impossible without social (cultural), which means without a specific value system (Bogdanović, 2012). Table 1 summarizes cultural values that characterize societies of economic prosperity and societies of economic stagnation.

From cultural descriptions of economic development and stagnation, it becomes obvious that culture is a complex construct described by using numerous characteristics (Bogdanović, 2012). In addition to the above, it is possible to determine some other characteristics for economic development. For example, an important cultural factor in the context of economic development and entrepreneurial success is trust (Bogdanović according to Fukuyama, 2000, 59). The essence of all the mentioned cultural data is in human resources and their culture (upbringing), and the social institutions based on them (Bogdanović, 2012). People with internalized values, social goals, and institutional behavior appear to be crucial for economic development (table 1). If the social elites accept the values as immanent/significant for the socio-economic development initiation, stay the question of their operationalization, that is, of internalizing the attitudes, values, and habits of a base of human resources through education.

Table 1. *Cultural values of economic prosperity and stagnation*

THE CULTURE OF ECONOMIC PROSPERITY	THE CULTURE OF ECONOMIC STAGNATION
Education is on a high level, it creates an informed and able workforce, prone to learning and self-improvement.	It does not create an informed and able workforce. Rejects/doubts new ideas and technologies. Society is not prone to learning and self-improvement; it does not appreciate the knowledge of its members.
Dedication to work, diligence, thriftiness, no pretentiousness, honesty, neatness.	Attachment to wealth, laziness, wastefulness, pretentiousness, dishonesty, and untidiness.
Very busy society, constantly on the move and changing.	Static, rigid, underemployed society, society in an "intellectual cage", changes do not happen easily.
An efficient government/state management recognizes the strong sides of other nations and adjusts to that.	Inefficient, incompetent government, corruption, bribery, rip-of "normal" social occurrences, and the existence of the rule of thieves.
It emphasizes equality and a larger middle class.	It emphasizes hierarchy (a few people at the top and a large low class).
It develops institutions with representatives.	Despot institutions.
Productivity and efficiency are the most important. "It does not matter if the cat is black or white, it is important that it catches mice!"	It discriminates based on irrelevant criteria (sex, religion, race, etc.) Intolerance, superstition, ignorance.
Encouraging initiative, urgency, and competition, excitement about something new.	Suffocating initiative, nourishing hypocrisy and not being open.
Suppression of pride for the greater good, fear of dependence on foreign production.	Pride, self-contentment, a paradox of the complex of superiority, not learning from others.
Optimistic and open culture.	Pessimistic closed culture.
People live to work.	People work to live.
Rational, important are facts and the truth.	Irrational, the motive and ideology are significant.

THE CULTURE OF ECONOMIC PROSPERITY	THE CULTURE OF ECONOMIC STAGNATION
Thriftiness, rational use of resources.	Lavishness, irrational use of resources.
Positive attitude towards modernization and industry.	Negative attitude towards industry and modernization.
Valuing work and sense for the goal.	Indifference/contempt towards common well-being, good management, and people.
Enterprise is an important and respected social factor.	Insecurity of enterprise.
Sense of commitment and duty.	Sense of obedience, satisfying vanity, spiritual homogeneity, doing something behind someone's back, being mean, feeling hopelessness, desperation.
Resourcefulness, imagination, full of ideas.	Lack of ideas and imagination.
Without prejudice.	A lot of prejudice.
Flexible, skillful.	Rigid, unskillful.
Inclination to earning and saving.	Inclination to spending and hedonism.
Curiosity, enterprising spirit, resourcefulness, being energetic, and activity.	Passiveness, lack of activity
Productivity.	Lack of productivity.
Social, cultural, and technological preparedness to use the money efficiently.	Lack of ability to use the money efficiently.
Direction to concrete, details, and precision, clarity is "the king".	Direction to general, abstract, not being precise, being unclear, manipulation.
Good relations between workers and management.	Bad relations between workers and the management.
Institutions are inclined to entrepreneurs.	Institutions are not inclined to be entrepreneurs.
Entrepreneurs have financial support from institutions.	Financial institutions are not interested in helping entrepreneurs.
Work, profit, and operational efficiency are social values.	Contempt towards business and economy (store and office).
Enterprise is a general trend, a part of the culture.	Enterprise based on distinctive individuals.
A society that has a program and a vision of economic development.	A society that has no program or a vision of economic development.
Creative-productive orientation.	Retail orientation.

Source: Bogdanović (2012) according to Landes (2003), author preparation and editing.

The mentioned social internalization (education) is possible in stages, and very similar educational mechanisms are already present (Bogdanović & Požega 2014) in the most developed countries of the world, Germany, and Japan (Bogdanović, 2005; Bogdanović, 2011):

- a. Defining the long-term entrepreneurial socio-economic orientation (vision and strategy).
- b. Schooling will support entrepreneurial-developmental values because this is where the strongest internalizing cultural effects can be obtained.
- c. Conversion of the behavior of administrative, financial, and political institutions as facilitators of entrepreneurship.

- d. Operative providing a general culture of work, knowledge, love/trust as a permanent process at all levels.

So, as a key factor in entrepreneurship, the culture of the society in which the entrepreneur lives and works is also important, so it cannot be bypassed in any serious scientific-professional considerations of economic and entrepreneurial development.

4 THE ENTREPRENEURIAL STATE

The success and development of entrepreneurship also depend on the state and the legal system and those people and institutions that

manage it. Economic freedom is the key to economic development. Development only ensures the state and the legal system with its supporting institutions. There are numerous for entrepreneurship important institutions: administration, courts, laws, monetary policy, import-export policy, purchase mechanisms, support for entrepreneurs, construction of accommodation and energy infrastructure, search and by finding jobs-markets, creating all kinds of demand, managing taxes, fulfilling assumed obligations, stimulating the banking system for favorable entrepreneurial financing, forming entrepreneurship education centers, etc.

Although a successful entrepreneur sees resources and opportunities where most see problems, even such a unique individual cannot succeed without elementary institutional support from the state and the legal system (North, 2003). This is because the state and legal system is an extremely important entrepreneurial factor in establishing the basic framework of socio-economic activity. That refers to the involvement of institutions at the level of legal, financial, and political assistance to entrepreneurs. Effective entrepreneurship is not possible if there is no real support, legal, institutional, financial assistance, and direct state aid mediated by a political decision which is often needed (e.g., when curbing import lobbies).

Entrepreneurship and economic development are not only technical or economic problems. They are also a political problem, a normative problem in economic science (Samuelson & Nordhaus, 1993). That is why there is a discrepancy between the profession and science on the one hand and economic policies on the other. In less developed and transitional countries, one of the significant obstacles to achieving development is that those who have power, are not truly interested in economic development and those who are interested in development do not have power (Galal, 2012). The combination of power and development interest is a prerequisite for real development achieving. Ignoring the problem of the distribution of power in society eliminates any possibility of achieving a quality diagnosis and realistic development problems. This can be a key demotivating factor in entrepreneurship.

To put it simply, the issue of development and entrepreneurship comes down to the state and the legal system, and those who manage it. Economic freedom for entrepreneurs but, also, all people is the key to economic development needs the state with its supporting institutions. In terms of economic development, therefore, there has not been any new illumination of the factors of wealth and poverty since the time of Adam Smith (1776) and his cult work "The Wealth of Nations", so the state and the legal system continue to play a key role there (Landes, 1999; 2003).

5 CONCLUSION

To alleviate poverty economic development is needed, i.e., entrepreneurship and innovation activity, and adequate distribution theory and practice. This article dealt with the key structural factors of entrepreneurship phenomena and the question of how to manage entrepreneurial factors to stimulate economic development for poverty alleviation. For management/government of economic development based on existing knowledge, three important entrepreneurial areas have been identified:

- a. "Homo entrepreneur" and his characteristics (personality traits, abilities, entrepreneurial knowledge, and skills).
- b. Cultural characteristics of society create a specific cultural climate/mentality in which entrepreneurial activity takes place.
- c. The state is an entrepreneurship master in its institutional, financial, and political behavior.

Necessary psychological resources of entrepreneurs/home entrepreneurs point to the need for psychological testing (especially extraversion, that are positively related to entrepreneurial success, neuroticism, which is negatively related) and intelligence, which should be at an average level with an emphasis on the necessary calculation skills, perceptual speed, and vitality/emotional energy. The qualities are easy to test in entrepreneurial training programs. These findings do not exclude the need to identify entrepreneurial talent and creativity from an early age, but also later so that they can be developed as entrepreneurial capital, that is, quality entrepreneurs/home entrepreneurs. It was determined that entrepreneurs need a lot of different knowledge/skills. They can be classified

into economic, management, innovation, and ethical ones. The suggested level of formal-organized education for entrepreneurship is that of the first cycle of higher education. It can be developed as informal or formal, raising formal levels to master and postgraduate studies. In addition to formal education, informal education in the context of lifelong learning is significant for entrepreneurs to maximize the transformation of their entrepreneurial knowledge into new products and services, and money.

Entrepreneurial culture with numerous for entrepreneurship and society important values which create a specific entrepreneurial cultural climate/mentality can be internalized from the earliest age. For economic development are important value changes in the implementation of long-term entrepreneurial socio-economic orientation (vision and strategy); schools as future creators and other important socialization factors, e.g., family, general people attitudes and behavior, institutions, and state behavior (which have a significant impact on value creation and behavior) that can support entrepreneurial and development values. The internalized values have good potential to make conversion the behavior of administrative, financial, and political institutions as facilitators of entrepreneurship, e.g., creating a general culture of work, knowledge, and love/trust at all levels. Cultural transformation in an entrepreneurial society is a long-term activity that supports all relevant socialization factors in the long-term perspective.

The state, through its institutional, financial, and political activities, can and should help

entrepreneurial activity using economic freedom and institutional support. That is possible through systematic and supportive action of supporting institutions and mechanisms. Some of them are crucial: administration, courts, laws, monetary policy, import-export policy, purchasing mechanisms, entrepreneurial support in problem areas, building infrastructure, searching, and finding jobs-markets, by creating overall or target demand, managing taxes, fulfilling assumed obligations, stimulating the banking system for favorable entrepreneurial financing, establishing educational centers for entrepreneurship and the like. The activity of the state and the legal system is also crucial for entrepreneurship and economic development/poverty alleviation. If there is no development interest from the state level entrepreneurship will depend only on peculiar individuals. Entrepreneurial culture and state in synergy can achieve full developmental and poverty alleviation potential.

Based on established knowledge and their persistent application, it is possible to accelerate entrepreneurship development by stimulating entrepreneurial entry into entrepreneurial projects, and longer retention of entrepreneurs in business, but also initiating more innovative activities in entrepreneurship by creating prerequisites for entrepreneurial success. Entrepreneurship as a wealth creator proves to be a key factor in economic development and poverty alleviation. To be an optimal and successful precondition is management excellence in governing society and economics in a smart, planned, systematic and long-term manner.

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SMART CITIES AND CITY LOGISTICS

Sergey Kirsanov

Branch of the Russian State Humanitarian University in Domodedovo,
Domodedovo, Russian Federation
<https://orcid.org/0000-0003-2338-0790>

Lyudmila Prigoda

Maykop State Technological University, Maykop, Russian Federation
<https://orcid.org/0000-0002-4762-3892>

Dragan Radovanovic

Independent researcher, Socanica, Republic of Serbia
<https://orcid.org/0009-0003-7326-2781>

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Abstract

Because of the constant influx of people, big cities are growing, and life in them is getting more challenging. City governments face increasing challenges related to the citizens supplying water and food, energy, public transport, roads, health services, and others for waste removal, recycling, and storage. Cities adapt to new conditions by using new technologies and innovative solutions. Cyber-physical systems, digitization, networking, cloud computing, the Internet of Things, and blockchains are tools that can help smart cities function. In this review paper, based on a review of relevant literature, the authors discussed some possible models for meeting the logistical needs of citizens in Smart cities. They focused on Smart-city technologies. The subject matter of this article is very complex and covers several disciplines, such as management, transport, and information technologies. Few have mastered the necessary knowledge in all these areas. The authors wish that this multi-dimensional presentation of the current situation will be helpful to those who deal with the organization of life in cities, logistics, or the application of information technologies in business organizations, but also ordinary citizens who are not yet familiar with these problems. The article should allow the reader to see the complexity of last-mile delivery and encourage it to use its potential to get involved in solving this problem.

Keywords: Smart City; supply chain; blockchain; logistics; last-mile delivery.

1 INTRODUCTION

The world we live in is changing rapidly. According to predictions, cities will include over 60% of the world's population by 2050 (Todorova, 2022). 70

Address of the corresponding author:
Sergey Kirsanov
ksaimr@mail.ru

percent of the total energy will be consumed in cities. The total emission of greenhouse gases in cities will also reach 70%. (Safonov, Kirsanov, & Čekerevac, 2022, p. VIII) That will bring many problems to their management. Citizens have a daily need to use very diverse resources and services. With the growth of cities, the challenges in their functioning also grow. This increases the need for the implementation of the Smart City



concept. That is why the idea of building smart cities was promoted more and more frequently in the previous decade. The common understanding is that the very idea of creating smart cities that will be comfortable, economical, sustainable, and environmentally friendly dates back to the 1960s (Vallianatos, 2015), but also to the year 2008 when IBM launched the term "A Smarter Planet" (Gavin, 2022). However, the idea is much older and goes back thousands of years. No one certainly wanted to build cities that were not comfortable living in. Only the circumstances changed over time, so different criteria were dominant at various times. Once cities needed high and strong ramparts, now comfortable housing, transportation, and what is considered an upgrade in living standards. Also, now we have more advanced technologies at our disposal, so we can use them to achieve the stated goals. This primarily refers to the mass application of information technologies in what is offered to the population. The most important thing is that this application must be in harmony with the environment so that cities can survive.

Information technologies are an indispensable factor in managing transportation, supply, logistics in general, water supply, waste management, and other services. Smart cities with the help of new technologies must create a favorable atmosphere for the life and work of their citizens. (Cekerevac & Bogavac, Logistics and last-mile delivery in smart cities, 2023)

Regarding logistics problems, Cekerevac and Bogavac discussed them in (Cekerevac & Bogavac, Logistics and last-mile delivery in smart cities, 2023). Here we will focus on city logistics and last-mile delivery. The term "last-mile delivery" refers to the last step in the supply chain regardless of its duration. The fact that it accounts for more than 50% of the total transport costs speaks of the importance of last-mile delivery. (Cekerevac & Bogavac, Logistics and last-mile delivery in smart cities, 2023)

This review study aims to systematize and summarize information about the state and trends in the last link of the logistics chain, last-mile delivery. Given the current trends in the cities' reorganization, the article focuses on logistics in the so-called smart cities. Due to the current interest of authors in finding alternative solutions, they paid specific attention to the process organization using blockchain technology.

2 MATERIALS AND METHODS

The study's conceptual basis is the system-functional approach. In this research, the authors used generally used scientific methods and techniques (deduction, comparison, induction, statistical analysis, scientific abstraction, and generalization), and methodological development tools (statistical grouping, graphical interpretations, etc.) to support theoretical positions and argumentation of conclusions. The authors used high-quality data obtained from relevant literature sources. The mentioned methods, used in solving the tasks set, made it possible to ensure a high level of representativeness of the results and the conclusions in the context of a unique algorithm for achieving the goal. The proper and complete citation of all used sources enables a high reproducibility of research results.

The authors used publicly available literature listed in the chapter References and the results of their previous research published in scientific papers and at scientific conferences.

During the research, the research question (A) was raised: What is the relationship between logistics service quality and smart-city technologies?

The null hypothesis for the research question can be set up as:

$H_{0,A}$: There is no correlation between logistics service quality and smart-city technologies.

The alternative hypothesis for the research question can be set up as:

$H_{a,A1}$: There is a correlation between city logistics service quality and smart-city technologies.

$H_{a,A2}$: There is a correlation between city last-mile delivery quality and smart-city technologies.

3 RESULTS AND ANALYSIS

3.1 Smart cities

From 2.5 billion people in 1950, 751 million (30%) lived in cities. The urban population increased rapidly. From 7.66 billion in 2018, 4.2 billion (54.8%) lived in cities. (Cekerevac, Prigoda, & Bogavac, 2022) If the predictions come true, the share of the urban population will increase to 68% by 2050. Now there are more than 8 billion people

on the planet Earth. Despite Asia's low urbanization, 54% of the world's urban population lives there. Europe and Africa are the next with 13% each. Projections show that people gradually shift from rural to urban areas, even from smaller to larger cities. Given the overall growth of the world's population, an additional 2.5 billion people could inhabit urban areas by 2050. According to the UN report, the largest share, close to 90% of this growth would be realized in Asia and Africa (UN, 2018).

To satisfy diverse and growing needs, from food to what is considered a luxury, changes must be preceded by the development of technologies. If they fail to meet the needs of their residents, cities are at risk of decay. There are countless such cities, and Chicago, the third largest city in the USA, can serve as an example. Despite immigration, Chicago lost about one million inhabitants in the last 70 years, from 3.6 million (1950) to 2.7 million (2020). (US Census Bureau, 2020). Economic conditions influence the outflow of citizens undoubtedly. Also, if all city services do not function satisfactorily, living conditions may become unsustainable. Such situations can arise suddenly, e.g. strikes of urban cleaning workers, e.g. in Rome (Reuters, 2018) (Matthews, 2021), Amsterdam (Hue, 2007), (Kievith, 2023), etc. That means that improving technology is not enough in itself. The human factor is very important.

To be "smart", the city must invest in the development of existing technologies and look for better solutions at the same time. For these purposes, the city must have relevant data when making decisions. In addition to the above, it is necessary to prepare residents for life in smart cities and training in the application of new technologies.

Smart cities developed different technologies to make citizens' lives easier. They can be grouped, and the most expectable groups are:

- Smart IoT devices,
- Smart energy,
- Smart mobility and transportation,
- Smart waste management, and
- Smart buildings.

Given the complexity of the topic, we will not deal here with all the issues that may arise in smart

cities. We will focus on logistics organization models and technology. For the needs of transportation, it is necessary to have an elaborate plan for continuous improvement of the intelligent transportation system. It will inevitably have to include a mass application of IoT, traffic scanning, developed video surveillance, electronic toll collection, and a system for finding free parking spaces and places to supply vehicles with electricity. Some of the cities faced with a shortage of parking spaces have introduced special parking spaces that can only be used for loading or unloading during store hours. After the end of working hours, other citizens can also use them. The correct selection of those places can greatly facilitate the problems of supplying stores and delivering goods to customers in the area. Most of the activities are based on massive digitalization.

3.2 Smart Cities and city logistics

Due to the growth of cities and their specificities, city logistics has become a significant segment of logistics. The term city (or urban) logistics usually refers to the ways and means used in urban areas to distribute cargo. City logistics can belong to any segment of the logistic chain, but usually, it belongs to middle-mile or last-mile stages. Sometimes middle-mile delivery can have several stages in the same city. Figure 1 illustrates such a situation in the example of a letter traveling from Belgrade (Serbia) to Maykop (Russian Federation).

A good city logistics model strives to apply appropriate strategies to improve efficiency and reduce harmful emissions, traffic congestion, and other negative side effects. Since the process is realized within cities, it hugely depends on the city in which it takes place.

In addition to what is common for all logistics chains (organization of transportation, roadways, GPS with its components, sensors, etc.), for city logistics, for city logistics modeling are crucial the location of logistics centers, the quality of city traffic, passability of streets, data on current and planned works that may affect some streets closing or the limitation of the width of the passage, the possibility of parking, the variety of the vehicle fleet and other, including the provision of a sufficient number of drivers and support workers.



Fig. 1 An example of a city logistics problem. Person A sends a letter to Person B

The environment dictates many constraints that a carrier must deal with to meet the demands of urban customers and business partners. At the same time, carriers must find new innovative solutions, which are often ad hoc solutions. This was also the case at the beginning of the COVID-19 pandemic when customers suddenly changed their previous habits. Home delivery has become a significant and even dominant way of selling. Retailers had to adapt quickly, and transporters faced major challenges. Many small vehicles had to be provided to transport small quantities of goods. Bicycles have become a significant factor in transportation. Such a rapid change brought, in addition to a change in the way of transporting goods, a change in the way of paying for delivered goods and charging for services rendered.

Current city logistics models have introduced many novelties in supply chains. Many models in middle-mile delivery often contain several small and micro hubs where shipments arriving from logistics centers are repackaged and distributed according to recipients' locations. These hubs are most often located within cities, which allows for a significant reduction in delivery costs. One of the best examples of this model is the delivery of postal items.

Because of their specifics, some authors, such as Rodrigue and Dablanc (2021), began to insist on conceptual differences and separate city logistics and supply chain management. He drew parallels between supply chain management and city logistics and addressed differences as organization v regulation, private v public actors, network v space, and efficiency v effectiveness. However, it is debatable whether it is justified or

not. City logistics is part of the supply chain. It has specifics, but those specifics also depend on whether it is part of middle-mile or last-mile delivery. (Cekerevac & Bogavac, Logistics and last-mile delivery in smart cities, 2023)

The goal of modern city logistics is timely procurement with the idea that stocks in stores are minimized and that they are aimed at satisfying seasonal consumption. Modern customers want goods promptly, eventually, tomorrow. That means smaller loads and higher frequency in distribution. The need for couriers and express delivery increased. According to estimates (Rodrigue & Dablanc, 2021), the movement of goods in urban conditions accounts for 20 to 30% of the kilometers traveled by all vehicles in the urban area.

Several smart-city technologies are significant for city logistics:

1. Intelligent Transportation Systems (ITS) helps to optimize traffic flows and reduce congestion. That includes traffic lights adjusted to real-time traffic conditions and tools for managing traffic incidents and redirecting vehicles to avoid congestion.
2. Fleet management systems use advanced telematics and GPS technology to monitor the locations, status, and vehicle fleet performance. That can help optimize routes, improve delivery times, and reduce fuel consumption. IoT use can also help control fuel tanking (Cekerevac, Matic, Djuric, & Celebic, 2006).
3. Predictive analytics can help to identify areas where traffic congestion is likely to occur,

enabling logistics companies to reroute their vehicles and avoid delays.

4. Smart Parking: Smart parking solutions use real-time data to help drivers find an available parking spot quickly and easily. That can reduce the time spent circling the block looking for parking, thereby reducing congestion and improving traffic flow.

Therefore, we can say that there is a correlation between city logistic service quality and smart-city technologies. Smart-city technologies using can improve the efficiency, safety, and sustainability of city logistics systems. Smart traffic management systems, for example, can optimize delivery routes and reduce congestion, while smart parking systems can streamline the delivery and pickup of goods. Additionally, real-time tracking and monitoring of vehicles and cargo can improve transparency and reduce the risk of theft or loss. Overall, the integration of smart-city technologies can enhance the quality and reliability of city

logistic services, leading to greater customer satisfaction and economic benefits.

3.3 Last-mile delivery and smart cities

Last-mile delivery¹ is becoming one of the most significant issues in supply chains. The main goal is to deliver packages from the final distribution hub to the customer at an acceptable price and within the agreed time frame. Modern buyers have the option of tracking their shipments during the entire journey from the seller to the delivery point. The period from the arrival of the shipment to the city until delivery is crucial for the overall picture of the distributor. Convey's research found that 84% of customers are not in the mood to buy again from a retailer that has not performed well in last-mile delivery. According to the same research, 98.1% of customers consider last-mile delivery to be key to brand loyalty. (Convey, 2018). Fig. 2 shows what customers think about how the brand should react if a package misses its estimated delivery date

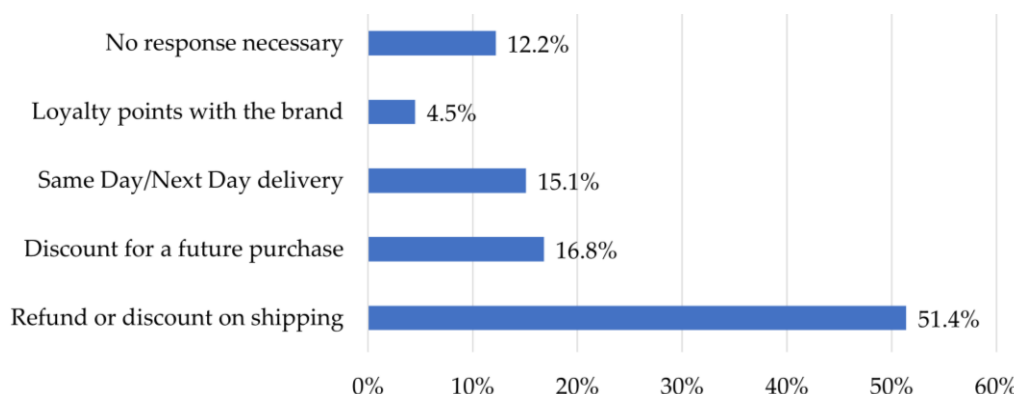


Fig. 2 How the brand should react if the package misses its estimated delivery date – from the customers' point of view

Source: Authors' visualization based on Convey (2018)

The same research showed that 62% of those surveyed stated that cost is the most significant factor in delivery, as shown in Fig. 3. According to Dolan's research (2023), last-mile delivery accounts for more than 53% of total delivery costs.²

The two biggest challenges for last-mile delivery are the number of packages that must be delivered and the number of recipients' addresses. Most often, recipients receive one parcel at their

addresses. The transporter is faced with solving the traveling salesman problem and the vehicle routing problem. Both problems belong to the NP-hard problems. Delivery is also affected by many additional factors. These may relate to priorities and scheduled delivery times, delivery vehicles drivers' schedules, vehicles' capacities, expected traffic congestion, the number of locations where shipments must be delivered, etc. At the same time, these factors do not always have the same

¹ Also known as last-mile logistics.

² The term last-mile delivery should not be taken literally but as delivery from the last in a series of distribution hubs.

weight. Depending on the situation, each of them can become dominant. The carrier must consider the expected stops for the delivery of the shipment at the delivery points, as well as the availability of nearby parking spaces. It must choose the proper delivery vehicle size to avoid situations where the vehicle cannot reach its destination. Repeated delivery is at the transporter's cost.

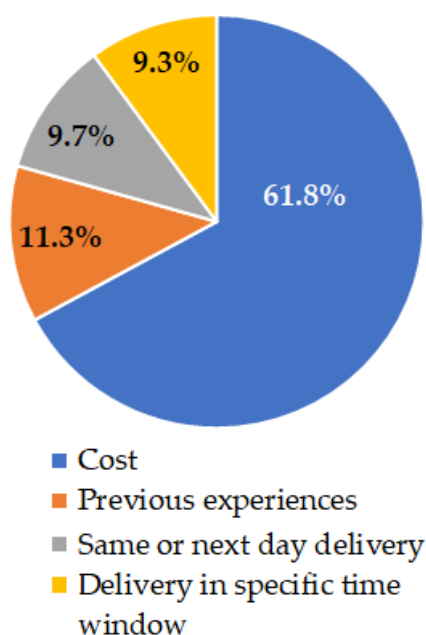


Fig. 3 The most important factor in delivery
Source: Authors based on Convey (2018)

Often packages cannot be delivered to the client. One of the reasons may be the absence of the recipient from the place of reception. Undelivered shipments require new communication with the recipient and a repetition of the delivery process.

With a small number of parcels and clients, an application of brute force can solve organizational problems. But, with many clients and parcels, it is necessary to use some predefined algorithms (branch-and-bound, branch-and-cut, or branch-and-price algorithms) and algorithms that use techniques reminiscent of linear programming. Because of the complexity of the problem, there are no ideal solutions. Carriers strive for an optimal solution by applying heuristics and meta-heuristics and often resort to hybrid methods that include all or some of the mentioned procedures (Kumar & Panneerselvam, 2012). Smart cities can

help in finding optimal solutions by providing up-to-date data on traffic conditions.

Many factors affect the price of last-mile delivery. Costs as an effect of the process of spending existing values to cover all the phenomena of the company represent the sum of the values spent in the realization of the set task. As presented in Cekerevac and Bogavac's article (Logistics and last-mile delivery in smart cities, 2023), in last-mile delivery, all costs are common for all companies in transporting goods as:

- the price and depreciation of the vehicle,
- fuel consumption,
- salaries of drivers and workers who work on the selection and loading of packages,
- route planning and records making,
- cost of software, and many other costs.

But there are also some specifics. Some costs are more pronounced. When parcels are transported on the highway when large vehicles run at a constant speed, fuel consumption is up to 50% lower than in urban conditions when vehicles run at low speeds with many stops, accelerations, and sudden braking³. With more stops, vehicles will be underutilized and idling longer. Also, compared to driving on the highway, the driver will spend incomparably more time behind the wheel for the same mileage, with significantly greater fatigue. Because in cities transporters use smaller vehicles, they need more drivers. When the complexity of the route increases, the same does the number of out-of-route miles. (Cekerevac & Bogavac, Logistics and last-mile delivery in smart cities, 2023) According to the research (Hochfelder, 2017), up to 10% of traveled kilometers refer to out-of-route miles.

In recent years, at least declaratively, increasing attention has been paid to sustainable development. New and stricter requirements to protect the environment are constantly being set. They force companies to introduce the care of the product during its entire life cycle. Manufacturers also must use as many recycled parts as possible. In the EU, according to Waste Act: Directive 2008/98/EC on waste (EU, 2008), what cannot be recycled must be disposed of safely so it will not

³ Depending on the truck model, road conditions, and driving style, fuel consumption ratios for driving on highways and cities can be different. Normally, trucks consume between 20 and 35 liters per 100 km on the

highway, depending on the load and speed. Fuel consumption in the city can be between 30 and 50 liters per 100 km because of frequent stops and movements in crowds.

endanger the environment later. The end-user, in the case of last-mile delivery, is a citizen. That is why we can expect that the lifespan of the product will expire right there. The location of goods delivery becomes the starting point in the new first-mile delivery, and that part of city logistics is connected to the waste management business group. Because of the human orientation and taking care of the product even after its useful life, we can hear the term "Reverse Logistics 5.0" more and more frequently, for example at Frederico (2021, p. 49), Jafari, Azarian, and Yu (2022), and others. While Industry 4.0 focused on autonomous solutions aiming to replace human workers, Industry 5.0 strives for harmony between people and technology. Likewise, Logistics 4.0, which relied on autonomous smart logistics systems, now tends to transform itself following the idea of sustainability. (Sun, Yu, & Solvang, 2022)

Companies have a specific problem with returned shipments. When shopping online, there is a high percentage of returned items. Their share reaches 20% (Dopson, 2021). In cases of returned shipments, the seller must either deliver replacement goods at his expense or return the money. To avoid the costs of the administrative tasks and taking the goods over, the seller often delivers new goods without taking already delivered shipment. The seller must calculate the costs of delivering the goods considering the possible return of the goods.

Large companies, national or multinational, very often offer the same prices for their products throughout the territory of a country, including the prices of delivery to the customer's address. This means that some average shipping prices are considered. This can be justified because neither the entire production is concentrated in one place, nor all the customers are concentrated in one place. Thus, some products travel longer from the place of production to the local logistics hub, but they travel shorter from the local logistics hub to the place of delivery and vice versa. It is possible to calculate the cost of transportation for each product individually, but at the time of purchase, it is usually not feasible, because of the unknown quantity and number of packages that will be transported from the manufacturer to the logistics

center, from the logistics center to the local micro-hub, and the local micro-hub to the place of delivery. Given that the last-mile delivery cost is more than half of the total transportation cost, it is necessary to choose the location of micro-hubs carefully. (Novotná, Švadlenka, Jovčić, & Simić, 2022) The correct choice of location can be decisive for the survival of the transporter. That is why, in addition to the investor's intuition, the transporters use much more sophisticated techniques such as e.g., multi-criteria decision-making techniques.

One way to simplify and cheapen last-mile delivery is to implement an automated network of parcel delivery lockers (APLs). The idea is to set up lockers at convenient locations in the city where the carriers will leave shipments, and recipients will be able to open the lockers and pick up the shipments by applying the appropriate codes. That improves distribution in the last mile by reducing the number of vehicles, the distance that vehicles travel, and the number of vehicle stops. This can also reduce the impact of transportation in the last mile on the environment. Delivery of parcels to the store closest to the customer's address is already in use. The customers pick up the goods at the chosen store at a time that suits them. The analysis carried out in the paper (Sawik, Serrano-Hernandez, Muro, & Faulin, 2022) gave encouraging results⁴.

Among others, Yu et al (Yu, Susanto, Yeh, Lin, & Huang, 2022) dealt with this problem, but they also included the possibility of parcels' simultaneous delivery and retrieval. Their research covered three possible places of goods delivery and pickup:

- home,
- parcel locker, and
- home or parcel locker.

Previous approaches have considered the simultaneous delivery and pickup problem with time windows (SDPPTW) in the cases of delivering shipments to customers and picking up return shipments only from customers. (Yu, Susanto, Yeh, Lin, & Huang, 2022) The authors named the new approach the vehicle routing problem with simultaneous pickup and delivery and parcel lockers (VRPSPDPL). Their research

⁴ The authors used Anylogic software and a CPLEX solver.

aimed to reduce the total costs of transportation to the lowest possible extent. Since there are no reference instances, they generated new ones based on the SDPPTW benchmark instances. As a limitation, they introduced into the model that home delivery and pickup can only be done in specific time windows, but there is no such limitation for parcel lockers. Experimental results confirmed the proposed algorithms' efficiency and effectiveness in solving VRPSPDPL. The authors claimed that their algorithms are more efficient than Gurobi⁵, even in small- and medium-size instances. In the case of large-size instances, new models are significantly better than Gurobi (Yu, Susanto, Yeh, Lin, & Huang, 2022). The proposed model is not omnipotent and should be improved by introducing realistic parameters such as the diversity of the carriers' fleets by types, sizes, and used energy sources, as well as by determining the optimal number and arrangement of parcel lockers.

Although parcel lockers seem the promising solution for last-mile delivery, it should be borne in mind that the final stage of goods delivery is left to the buyer. One should also keep in mind the limitations of this delivery method, as it is unlikely that the customers will agree to carry the refrigerator, furniture, or ceramic tiles from the location of the locker to their address.

One of the possible additions to such a system is crowd shipping. It is also suitable for sellers with small physical stores as it allows them to leverage their stores' network to compete with the high standards of big companies. They can deliver their goods on the same day and fulfill the increased demand and application of e-commerce. The idea is to involve amateurs in last-mile delivery instead of professional transporters. The transporters are people whose journeys in certain situations coincide with the needs of transporting goods in the final phase. They pick up the goods in shops or micro-hubs and transport them in their vehicles. For that, they receive appropriate compensation. In this way, the transporter can achieve lower delivery prices and fast delivery. Given that amateurs appear here as participants, prior and constant verification of their reliability is necessary. The driver applies for a job by using specialized

platforms⁶. There are different ways, including video interviews, for initial checks. During the engagement, the recipients evaluate the drivers after the delivery of the shipment. That allows a higher level of reliability to be achieved. The most suitable carriers for each delivery are selected using appropriate algorithms. Companies that organize this kind of delivery system usually provide insurance for packages. (Hanzlik, 2015) Some platforms allow the sender to choose among different modes of transportation: commuter, motorcycle, and vehicle. The first one can be slower than the others, but it is the cheapest (Abudheen, 2019). With its potential, crowd-shipping may soon become a significant factor in the sharing economy. They can be a good chance for SMEs to reduce logistics costs and improve logistics efficiency. However, this mode of transportation is not always reliable because it is frequently unavailable. Several factors need to come together. There should be a suitable driver with an appropriate vehicle in the vicinity of the place from which the shipment is to be picked up. Also, the driver's route should coincide with the required for the shipment delivery at the specific moment. Significant driver and vehicle base increases could increase the system's reliability. Mittal et al (Mittal, Marusak, Krejci, Sadeghiamirshahidi, & Rogers, 2022) evaluated crowd-shipping platforms to find how they are suitable for SMEs. They requested pro-forma invoices for delivery service based on the shipping requirements that two agriculture-based SMEs in Texas use in their practice.

As mentioned, smart cities can help transporters to organize intelligent transportation systems for last-mile delivery by providing appropriate data in real time. The number and position of vehicles used for delivery vary over time, so it is reasonable to say that fleet networking involves vehicular ad hoc networks (VANETs). In smart cities, vehicular networking is a crucial component of intelligent transportation systems. The obtained data enable the creation of an 'Internet of vehicles'. If VANETs optimization is successful, the system benefits can improve last-mile delivery in urban and suburban areas. But system optimization brings with it numerous challenges. The problem is even more pronounced because it must be solved in real time

⁵ Gurobi Optimization is a decision intelligence technology for optimal decision-making.

⁶ Some of the platforms are Peer and PiggyBee.

and an uncertain and dynamic environment. In the paper (Peyman, et al., 2023 Jan), one such simulation was performed on the example of Barcelona using data downloaded from Open Data Barcelona. The results showed that the constructive heuristic outperforms the random scenario in the customer data platform combined with vehicular networks. Better results are achieved in shortening the distance between facilities with meeting capacity requirements using the fewest facilities (Peyman, et al., 2023 Jan).

Besides named smart-city technologies, last-mile delivery solutions use technologies such as drones, autonomous vehicles, and intelligent lockers to speed up the last leg of the delivery process. We will discuss it in the next subchapters.

At the end of this subchapter, we can conclude that there is an interconnection between last-mile delivery and smart cities.

4 CONCLUSIONS

Life in big cities brings challenges for both the population and those who need to provide residents with favorable conditions for living and working. The situation is complicated because the cities were designed in different conditions than today. Hardly any big city has the projected capacities for the current number of inhabitants and the current standard of living. Therefore, cities must try to become "smart" and adapt to the new criteria. The problem is that these criteria also change over time, so constant adjustment and making projections of future development are necessary. One of the problems faced by smart city creation is logistics, more precisely, last-mile delivery. Usually, logistics centers are on the outskirts of cities, and from there, merchandise should be transported via micro-hubs or directly to the customer. Although last-mile delivery is the same as other logistics in terms of principles, due to the conditions in which it takes place and the set requirements it has its specificities. The main differences are in the number and size of shipments and the number of recipients. That highly affects the choice of delivery method, the required number and size of delivery vehicles, the required number of drivers and supporting staff, the choice of optimal vehicle paths, communication with the recipient of the shipment to reduce the risk of shipments non-delivery and,

ultimately, the cost of delivery. Last-mile delivery average costs are higher than costs in the rest of the supply chain.

The accuracy and quality of last-mile delivery affect the overall image that the customer acquires in doing business with the seller.

Customers expect delivery on the same day or at the end of the next day, on time and in good condition, without damage, and in the agreed quantity.

It is a challenge for all participants in the logistics chain. Technology can solve many problems, but people remain the most important. They should come up with models that will allow the customer to be satisfied. Blockchain technology is one of the promising technologies. It deserves great attention and high expectations. Blockchain technology allows every participant in the supply chain and customer to receive information about the goods and the shipment location in real-time without fraud. Information, once linked to the chain, cannot be changed. Only new data can be entered. With more links in the chain, fraud becomes more difficult, if not impossible. We recommend different private blockchains for different needs. That enables higher speed in entering new data and less need to include those who are objectively not interested in what is in the chain. The Ethereum-based platforms have proven to be stable and fast enough for many participants. Blockchain technology will be particularly effective in the automated delivery of goods and synergy with the IoT. The share of manual work will be reduced significantly, and thus the delivery cost. When automating delivery, the use of drones will bring additional benefits. Greater expectations are from ground drones that move along roads, but UAVs also have a perspective, especially in the delivery outside the city due to the reduced risk of damage due to the possible fall of the drone. There is still no universal legal regulation related to drones. It represents a significant limitation for drone use.

The results of the analysis from subchapter 3.2 reject the null hypothesis $H_{0,A}$ that "There is no correlation between logistics service quality and smart-city technologies" and confirm the alternative hypothesis $H_{a,A1}$, according to which there are cases where "there is a correlation

between city logistics service quality and smart-city technologies.”

The results of the analysis from subchapter 3.3 also reject the null hypothesis $H_{0,A}$ and confirm the

alternative hypothesis $H_{a,A2}$, that “there is a correlation between city last-mile delivery quality and smart-city technologies”.

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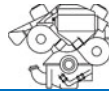
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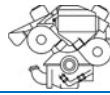


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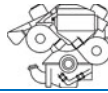
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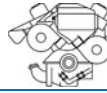
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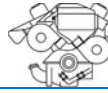
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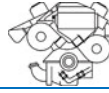
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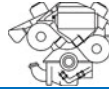
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