Impact of Digital Technology and Smart Systems on Mobility and Agriculture in Serbia

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Abstract As mobile device location data becomes more available, new analyzes reveal significant changes in the way you navigate when an unplanned event occurs. With different control policies from local and state governments, the outbreak of Covid-19 has dramatically changed travel behaviour. In particular, the necessity of fundamental changes in certain sectors was noted, some of which are mobility and agriculture. Not only the pandemic, but also urbanization, climate changes, ecology and especially the ongoing War in Europe, marked these two categories as very important and connected, crucial for future survival in unpredictable new circumstances. Examples of agriculture in the Netherlands and Serbia were analyzed, as a possibility for the application and implementation of new solutions. The concept of precision agriculture, connecting new technologies and a traditional branch of the economy such as agriculture, enables functioning even in extreme conditions, such as limited movement during the pandemic and locking.

Keywords: mobility, precision agriculture, technology, smart systems, Serbia

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1 Introduction

For most of the 20th century, it was believed that increased traffic safety was achieved by separating vehicles from other road users. In order to apply the principle of common space, streets must be specially planned and equipped for slower traffic. In the new circumstances, it is necessary to predict movement and logistics for specific conditions, such as the pandemic. This requires the application of various project solutions, before various researches had carried out. The negative impacts of today's traffic, is a growing initiative for change in terms of improvement. There is a global need for implementation new ideas and systems that would change the negative impact of traffic in the future (Cvitković *et al.* 2021). Smart technologies and systems have proven as the most adequate and universal solution for all conditions.

During the first wave of the pandemic, mobility decreased sharply across Europe. The effect was stronger in countries with stricter lockdown policies, while countries with politically oriented or partial lockdowns also significantly reduced mobility. Until now the Covid-19 pandemic had an unprecedented impact on traffic in general, but also on the sector as a whole, the consequences of which are felt in the reduced number of passengers, and therefore also in the financial consequences. As mobile device location data become more available, new analyzes reveal significant changes in the way you navigate when an unplanned event occurs.

With different control policies of local and national authorities, the outbreak of Covid-19 has dramatically changed the movement behavior in the affected cities. Many countries have closed their borders and imposed curfews in a sharp reduction in transport demand both regionally and continentally. Different countries have dealt with these challenging circumstances in different ways – and, in some cases, directives differ from city to city. Cities in developing countries and emerging economies face greater challenges than ever before. At the beginning of the Corona virus (Covid-19) pandemic, Google and Apple started collecting detailed statistics about people's movements using location data from mobile devices. The paper analyzed the data obtained for different areas of movement such as shops, recreation areas, parks, public transport, etc.

Also, as these digital data were very important in the coordination of the crisis, so also a very important sector such as agriculture had to be adapted to the new circumstances. In conditions of lack of food due to global challenges such as the pandemic, energy crisis, wars, digitalization of agriculture and the use of smart technologies and solutions, they are inevitable. The example of agriculture of Netherlands, as one of the leaders in this field, turns out to be useful for a country like Serbia, which has a huge natural potential.

2 Using Digital Technologies in Order to Obtain Mobility Data During the Pandemic

The Coronavirus pandemic has a significant impact on countries around the world and many countries have imposed restrictions on transportation. Different countries have dealt with these challenging circumstances in different ways, in some cases, directives differ from city to city. How effective these guidelines have been in reducing people's movement can be seen from the data Google presents in its Covid-19 mobility reports. Using anonymized data provided by apps like Google Maps, the company created a regularly updated dataset that shows how people's movements have changed during the pandemic (Badr *et al.* 2020).

This mobility data can provide useful insights to local governments and health authorities, and colud be used as a basis for new public policies by showing the change in the extent of mobility of people in their communities.

We can learn about this from the data that Google presents in the report on community mobility. The United Nations and other organizations source and categorize data into the following categories: social distancing, movement restrictions, public health measures, social and economic measures, and blockades (Lapatinas 2020).

Table 1: Policy measures considered in the analysis

Category	Measure	Description
Social distancing	Limit public gatherings	Cancelation of public events. Limit to the number of people that can meet in public and private spaces.
	Public services closure	Public services and facilities are closing access to the public. In some countries, services are available online.
	Changes in prison policies	Change in policies around prisons to mitigate the spread of the disease. This may include early release but also suspension of day-release programs, suspension of visits etc.
	Schools closure	Authorities have closed schools.
Lockdown	Partial lockdown	Partial lockdown includes: 1. The population cannot leave their houses apart for specific reasons that they have to communicate to the authorities. 2. All stores that are not related to alimentation or pharmacies are not open.
	Full lockdown	Full lockdown includes: 1. The population cannot leave their houses apart for specific reasons that they have to communicate to the authorities. 2. All non-essential services closed and production stops.
	Lockdown of refugee camps	Limitations to the population living in camps and/or camp like conditions.

Source: (Cvitković *et al.* 2021).

Google has published reports on community mobility that show trends in movement by region, in different categories of places. For each category in the region, the reports show changes in two different ways. Compares the mobility for the report date with the base day. Calculated for the report date and displayed as a positive or negative percentage. The reports show trends over time by geography, in various place categories such as retail and recreation, grocery and pharmacy, parks, transit stations, workplaces and residential.

Table 2: Description of mobility reports categories

Category	Description	Data Source
Retail and recreation	Restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres.	Google
Grocery and pharmacy	Grocery markets, food warehouses, farmers markets, specialty food shops, drug stores, and pharmacies.	Google
Parks	National parks, public beaches, marinas, dog parks, plazas, and public gardens.	Google
Transit stations	Public transport hubs such as subway, bus, and train stations.	Google
Workplace	Places of work.	Google
Residential	Places of residence.	Google

Source: (Cvitković *et al.* 2021).

Using anonymous data provided by apps like Google Maps, the company has created a regularly updated dataset that shows how people's movements have changed during the pandemic. This data set measures the number of visitors to specific categories of sites on a daily basis and compares this change to the initial day before the outbreak.

2.1 The impact of the Covid-19 pandemic on changing mobility

People increase their activity at home and reduce their mobility at workplaces in the first months. The results confirm the assumption and show that, in the early phase of the pandemic, workers in the subsectors reduce their activities at workplaces and increase their activities at home when the number of new daily cases increases. This suggests that people tend to increase their activities at home and decrease their activities at the workplace. Until the pandemic, home jobs were generally considered a non-standard, flexible work arrangement, where the workplace was the employer's place. Of course, during the pandemic, employees worked from home out of necessity rather than choice, and the formalized flexible working regime fell somewhat. Many employers are also considering long-term downsizing of office space and moving to hybrid working, allowing employees to split their time between working from home and working in the office.

The analysis suggests that the blockade has the strongest causal influence on increasing presence at home and decreasing visits to workplaces, public transport hubs, groceries, pharmacies, open public spaces. The impact of closing public services and closing schools is significant, but on a smaller scale. The results show that the most effective COVID-19 policies to reduce mobility are closure of public services and facilities, partial closure and full closure.

3 The necessity of change as a consequence and introduction of smart systems

A clearly visible side effect of the Covid-19 pandemic is a reduced need for daily mobility. This can mainly be attributed to the expansion of telecommuting, the movement restrictions that have been imposed in countries and the decreasing sense of safety in public transport. Long-term changes to telecommuting or virtual mobility might be result in time changes, including less frequent travel. Improving

cycling and walking accessibility could improve traffic safety, health and the environment. During the pandemic, many cities began to expand existing cycling and pedestrian infrastructure, first as temporary solutions, to gradually, wherever possible, make them permanent. Continuing the trend, many regulators will focus on environmental issues when adopting mobility guidelines. Urban mobility and, in particular, its management are undergoing a period of profound change to enable sustainable mobility in small and large cities. After the COVID-19 pandemic, we appreciated living with better air quality and less noise. Movement restrictions have shown us the extent to which streets and public spaces in our neighborhood are essential to community cohesion. By suddenly entering the »new normal« we learned the hard way that behavioral change at the community and individual level can happen at a much faster pace than we thought. According to Kotler and Bloom (1984) intangibility was defined as everything that cannot be seen, tasted, heard or smelled (Vujić, et al., 2020), so sometimes we don't see all the hidden changes. The environment is exposed to the negative impact of business activities, which is reflected in extensive exploitation of natural resources and pollution of nature.
Based on this research, it was determined that drastic changes in mobility during the pandemic affect various spheres of life and economy, including agriculture. The concept of smart agriculture is already being applied in Serbia, but after the pandemic and changes in mobility, the need for the concept was seen as inevitable.

3.1 Smart traffic

Smart traffic and smart mobility are two intertwined concepts, and they are unthinkable without each other, because mobility is a service, and the biggest service and need today is traffic. By applying smart technologies and smart solutions, traffic is regulated, which affects the reduction of costs and the increased satisfaction of passengers, pedestrians, or drivers. All IoT solutions are based on the application of smart and environmentally sound cars, and their connection to traffic infrastructure and infrastructure facilities such as gas stations, parking lots. Apart from communication, more modern solutions of IoT technology lead us to communication between vehicles, with each other (Inić 1997).

One of the services and smart solutions of modern technologies is the monitoring of traffic at a given moment (in real time), and these are vehicle navigation systems, as well as systems for locating cars, enabling the provision of information on the distance from other traffic participants, information on the current state of the car, as well as the condition of the roads and potential accidents on the roads.

Smart traffic consists of:

- Smart vehicles;
- Smart infrastructure (Stojkov & Resanović 2016).

3.2 Smart agriculture

In London, the sewage network had done only after the cholera pandemic in 1850, perhaps now is the time to adopt the best technology and infrastructure for smart cities and villages. The digital revolution is underway and agriculture has not been bypassed. On the contrary, new technologies have also found application in agriculture. Integrations between agriculture and new technologies, mainly from the IT industry and others, are called by one name – smart agriculture (Faculty of Agriculture 2022).

Earth observation by remote sensing (EO) is the interpretation and understanding of measurements made by airborne or satellite instruments of EMR that is reflected or emitted by objects on the Earth's surface, ocean or ice surface, or in the atmosphere, together with establishing the relationship between these measurements and the nature and distribution of the phenomenon on surface of the Earth or in the atmosphere (Mather 1999). In this way, we can use the recordings for various purposes of the functioning of villages and cities, as shown in the previous example of tracking via google mobility during the pandemic.

Today, around 70% of the world's population lives in cities, and that percentage will probably increase more and more, so it is necessary to use all agricultural potentials to ensure enough land, food, meat, fruit and vegetables, etc. (Figure 1). For this reason, we should invest in agriculture, help the rural population, and protect water and the environment, in order to ensure the healthiest and highest quality products. In Serbia, modern agricultural production that also takes care of environmental

protection has become the present. ICT provide precise mechanization and an Internet network in which machines, objects, people and animals are networked, as well as data analysis collected by drones and robots. The biggest problem for farmers in Serbia is how to bridge the gap between traditional farmers and scientists, how to use all the technical devices and technological possibilities of today? The Government of the Republic of Serbia and the Ministry of Agriculture often organize various forums, seminars, conferences in order to attract young people not to leave the village but to advance in agricultural activities. The future of agrarians is family farms equipped in a technical and technological sense, and united in cooperatives (Kostić 2005).

Availability of land resources per inhabitant in the time domain, Bruinsma, J. 2009.

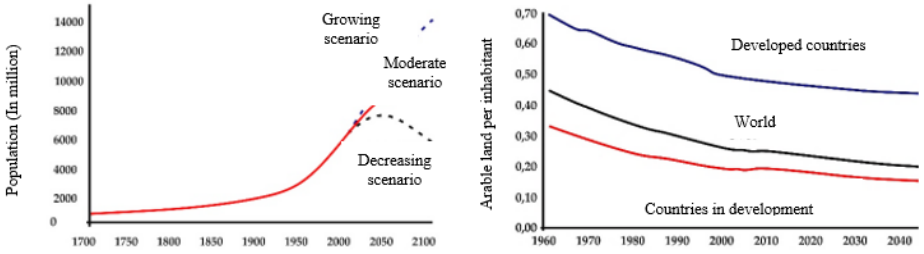

Figure 1: Human population growth with forecast of further trend, Ganivet E. 2019.
Source: (Kostić, 2021)

4 Serbia's potential for smart agriculture

Rural areas are riched by ecosystems and biodiversity, natural rarities, various activities, cultural and historical heritage (Borović et al., 2022). Serbia is a country with a diverse geographical structure: varied relief, pleasant climate, wealth of natural resources, fertile plains in the north, hilly and mountainous area south of the Sava and Danube, the Pester plateau. All these factors tell us that Serbia is a country with great agricultural potential. The types of land in Serbia are numerous, with huge areas that are not fully utilized, or uncultivable. More than a million hectares of Vojvodina are chernozem, while in the southern regions there is a lot of uncultivable land that can be used for organic agriculture, because organic fruits, medicinal herbs, and vines thrive even on poor quality land. Serbia also had potential for traditional agriculture, but the performance can be many times better and greater when agriculture is also

modernized and digitized, so that in the future it can be one of the leading countries in Europe in the agricultural and food industry (Ristić, Barbarić, 2019).

The process of modernization of agriculture is represented, in the north smart farming, and in the south smart animal husbandry and smart farms. The state must build the entire chain, from the first step and tilling the land, to the processing and production of finished products. One link in the chain has stopped, Serbia exports wheat, corn and other basic products of agricultural production, but imports finished agricultural products. This is a characteristic of poorer countries, they are rich in natural resources, but the processing industry has »failed«.

4.1 Necessity in using smart systems and mobility in agriculture in Serbia

4.1.1 A positive example of the Netherlands

The best example for farmers should be the Netherlands and it's agriculture. Compared to that relatively small country, Serbia has 3 times more arable land and 76% more available fresh water. However, on our fertile land, the income is 3t of grain from one hectare, and farmers from the Netherlands, as much as 8.5t from one hectare. In addition, they have developed the entire chain of the food industry, from seeds, through processing to the finished product, so the Netherlands is the second country in the world in terms of food exports, right after the USA. The government of the Netherlands invests a huge amount of money in projects it calls »sustainable, smart and circular agriculture« In the absence of fertile land, the Government of Netherlands is dried a part of the sea, cultivated that land and made it fertile (Kostić, 2005).

Farmers use sensors, drones, and farmers use drones and robots, and in all sectors, from cultivation to processing and packaging of finished products, they use automated processes. Because of these smart and sustainable solutions, the Netherlands is a leader in efficient and sustainable agriculture in the world, even though it has limited natural resources (Figure 3). With the introduction of IoT technology, smart and innovative solutions, modern sensors are available for farmers to use. This system helps us get real-time data and make the right decisions. With the help of sensors and IoT technology, farmers monitor the water level in the reservoirs, thus increasing the efficiency of water supply, i.e. irrigation. Using sensors

and smart technology, farmers monitor the growth of seeds, that is, they measure the consumption of resources and the time it takes for the seed to grow into a plant ready for processing or picking. By applying modern techniques, the yields are many times higher, less labor is required, a great saving of time, and almost no losses from drought or floods, because systems against droughts, i.e. protection against floods and natural disasters, were created (Polovina, Kostovski, Popadić, Milijašević, 2019).

5 Precision agriculture

There is no clear difference in the interpretation of the concept, as synonyms such as site-specific farming; smart farming and digital farming appear. On the official website of the University of Lleida, researchers from the AgroTIC department gave 27 different interpretations of the term precision agriculture (Lleida University, 2018). It is not clear what is meant by the term precision agriculture technology (Kostić, 2021). Precision agriculture is anything that makes the farming process precise (accurate and controlled) when it comes to raising livestock and crops and growing crops. One of the most famous and important applications of IoT in agriculture is precision agriculture (another name is satellite agriculture). The goal of precision agriculture is to analyze the data obtained by sensors, and react based on them, i.e. make intelligent and faster decisions, as well as monitoring the operation of machines and quality analysis of samples. This makes farming precise and controlled. The concept of precision agriculture enables many times higher yields, using fewer resources, on a smaller area. The advantages of modern technology are that things can be managed remotely; farmers or farmers do not have to be physically present. In this way, greater efficiency and precision are achieved, while reducing costs, money and time (Kostić, 2014).

Smart technologies and sensors provide information about weather conditions, pests, soil quality. Modern agriculture takes place with the help of artificial intelligence, smart IoT sensors and robotics, and the aim is to show how technology can make agriculture and industry more efficient and productive.

5.1 Agricultural drones

An agricultural drone is an unmanned aerial vehicle that has multiple purposes and functions:

- Yield optimization;
- Irrigation efficiency;
- Pest and disease control;
- Cattle control.

With the combination of IoT technology and drones, great progress can be made in the agricultural sector. Using drones, precise 3D maps can be placed when planting seeds and crops. Such drones recognize parts of the land that are dry or require fertilizer.

The advantages of using drones: until now, there was no machine that performed functions like drones. Tractors with tanks were used for guidance, mostly human resources for monitoring.

- Speed. Spraying soil is 50 times faster with a drone than the traditional way.
- Savings. During spraying or irrigation, 90% of water and about 40% of pesticides are saved.
- It also saves crops, because the drone flies above the crops, it does not trample the crops like a tractor.
- Security. The drone does pollination, no one has contact with chemicals-pesticides and
- herbicides (Kostić, 2014).

5.2 A smart farm

The Internet of Things (IoT) in animal husbandry also has a large application; it is used to monitor the movement and health of animals. Also, smart technology allows insight into the complete supply chain of hay, water and nutritional supplements, from the entry of feed into the warehouse until the moment the cows eat the feed. IoT devices are placed in the collar and monitor the movement of the animal, as well

as its advertising, the animal's activity is also measured. The animal's collar contains sensors that measure temperature, pressure, physical activity, heart rate, need for food or water (Zoranović, Bajkin, Vujić, 2009).
Based on that data, classifications are made among them, they are sorted by categories, and their medical condition is monitored. With the help of IoT technologies, a sick animal is identified, separated from the herd and treated. The goals of smart farms are: increasing milk and the quality of milk products, reducing the volume of labor, identifying livestock diseases, providing healthy food and correct water.

Modernization of farms has started in Serbia, we have several examples on the Pešter Plateau, where family farms have technically and technologically improved their stables and farms, we have a case of milking cows using robots. The Milka robot, which is the only one in Serbia, milks 6 cows at the same time, squeezes the milk and directly delivers the milk in a tanker ready for sale. After milking the cows, the robot goes around the stalls where the cows are housed and distributes food to them, based on their needs (Kostić, 2014).

6 Disadvantages of the implementation of smart agriculture in serbia

A rural area could be defined as „an environment with a small population concentration, whose main occupation is agriculture, characterized by a special way of life, work, customs and village identity. According to the traditional approach, rural areas in Serbia include 70% of the total territory with 43% of the total population, and according to the OECD definition, rural areas include 85% of the territory and 55.5% of the population with an average population of 63 inhabitants per km^2“ (Cvijanović, et al., 2009). Agriculture in the Republic of Serbia, in addition to the great age of farm owners, is also affected by the fact of a very low level of education, where generally only 6% have higher education, and even 49% without any formal education.

A prerequisite for transitioning to modern technology is understanding the effects of application, which requires basic knowledge of natural and technical sciences. All of the above is largely absent and it is realistic to expect that, if there is no insistence

on the education of farmers, it is questionable how quickly the agricultural practices of Serbia will adapt to current trends.

7 Conclusion

The rapid advancement of technology in the field of agricultural production is significant, because the need for food is increasing day by day. Due to this rapid progress of technology and technique, in the future, a staff will be needed who will know how to manage and maintain the technique and technology of agriculture (Faculty of Agriculture, 2022). Among the priorities, it is necessary to include a new methodology of development, based on local subjects while using the advantages offered by the given region. Novaology improves and ennobles the environment, promotes development and gives new chances for young people who are leaving. Considering that there is little research that deals with this relatively new topic for the needs of regional development, a number of new researches should be conducted and a special dimension should be given to the development of specific regions.

As in other sectors, agricultural producers inevitably turn to technological achievements in order to produce more profitably. Due to the high investment prices of smart agriculture and the problems that Serbia has in the purchase prices of products and the departure of young people from the countryside, there are still no significant investments in the development of new systems. There is a global tendency to apply the most modern technology, ICT systems, then the systematization of agronomy knowledge, but the fact is ignored that farmers are a population of people who, by tradition, in all countries of the world have the lowest level of education (Kostić, 2021).

The necessity of multidisciplinarity is recognized, which is lacking in scientific circles as a result of individualism and specialization in only one field. Also, the spread of the COVID-19 virus pandemic changed perceptions and movements and highlighted the previous thesis of abandoning individualism. Social distancing and lockdowns have affected mobility globally. The necessity of using digital tools, artificial intelligence (Sridhar, et al., 2022), in general precise, smart agriculture as a platform to overcome the crisis of modern challenges, from pandemics, wars to climate change and lack of food on the planet, has been established.

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