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OPPORTUNITIES FOR DIGITISATION OF AGRICULTURAL AND RURAL DEVELOPMENT SOLUTIONS[1]

Vilma Atkočiūnienė [1], Palmira Papšienė [2]

[1]*Prof., Dr., Vytautas Magnus University Agriculture Academy, E-mail address: vilma.atkociuniene@vdu.lt*

[2]*Junior researcher, Vytautas Magnus University Agriculture Academy, E-mail address: palmira.papsiene@vdu.lt*

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Abstract
Agriculture identification of solution alternatives and their effective implementation require human resources capable of concentrating and systemically setting priorities and performing necessary tasks for realization of ideas. With the help of agricultural digitization, one employee can communicate with several robotic devices at once by sending them specific instructions, thereby synchronizing their work with each other. Such activities in agriculture help to save time and achieve higher productivity. *Purpose of the study is to analyse opportunities for digitisation of agricultural and rural development solutions.* The focus is on one of the options, the aim is to define how in a digital environment, using decision support systems (DSS), one employee can carry out several jobs and, according to feedback signal, perform their quality monitoring. Using digital technologies in agriculture and rural change management, employees can guarantee that every modern agricultural and rural development management system will start its work on time, perform it qualitatively and finish it on time. An employee can monitor the processes of change in agriculture and rural environment with the help of information technology. With the help of internet technologies and robots, implemented advanced information systems (such as DSS) can collect, analyse and process huge data (metrological, soil conditions, market information, etc.), so one person can perform several jobs at the same time. In order to successfully address the challenges of digitisation of agriculture and rural development, it is proposed to facilitate cooperation between a human (operator) and a robot when they exchange and (or) share tasks, control multifunctional processes, and, according to the obtained results, make changes to the components of the process in order to achieve the best result.

Keywords: *digitization, decision support systems, agricultural and rural development.*
JEL Codes: *O15, Q1.*

Introduction

The ever - changing environment forms a new approach to human resources management in the agricultural sector. Progressive changes include human resources, which become the most important factor ensuring the efficiency and quality of the agricultural sector's goals and providing flexibility to respond more quickly to the dynamic political and natural environment. Di Nardo & Yu (2021), Paschek *et al*. (2019) note that the Fifth Industrial (Industry 5.0) revolution is characterized by synergy between human and technology, associated with the interaction of human intelligence and technology, combines human capital with robotics to achieve productivity and speed in its field, while at the same time ensuring the environment, paying greater attention to renewable energy, and reducing pollution. Therefore, digitization in agriculture plays a very important role. Emerging new technologies are rapidly making their way not only in business models, but also in various branches of agriculture. The application provides opportunities for more than ever adapting to changing customer needs, increasing resources and increasing uncertainty (Kunath & Winkler, 2018). As well as achieving higher labour productivity, which results in a higher quality, often more nature-friendly, product at a lower cost. From an agricultural perspective, digitization has led to

more accurate and efficient actions, event predictions, and action-consequence relationships. Bičkauskė *et al*. (2020) note that the lack of human (e.g., innovation experts) and financial resources and the fear of incurring even higher costs are still considered to be the main obstacles to taking the digitalization path. However, increasing information flows led to stressful and responsible preparation of the employee for new activities, which can affect the quality and productivity of work. Therefore, digitization is inseparable from computer management, and employees can mobilize focus on other issues to be addressed. A large amount of information and multi-tasking at the same time make it possible to achieve better results in agriculture through digitalisation. Digitisation enabled modernisation of agricultural management through the introduction of precision farming principles (Finger *et al*., 2019), expanding the functionality of working machinery and harvest monitoring (Ünal & Kızıldeniz, 2023, Lee *et al*., 2022). A large amount of information that carries out analytical work in the digitization of agriculture is successfully solved with the help of modern information technologies, adapting robotic mechanisms capable of independently performing routine tasks that are planned in advance. A modern agricultural worker must be fully knowledgeable, know the functional capabilities of the controlled mechanisms in order to fully utilize them to increase agricultural productivity. The worker would also be able to independently control or reprogram a robotic unit, adapting it to a specific need. Scientific research carried out deepening the situation of human resources management (Klupšas, 2007, 2008; Adamonienė, 2009; Melnikienė, Eičaitė & Volkov, 2018; Mockevičius, 2022) defines the perspectives of agricultural development in the context of progress and sustainability. Ongoing changes in agriculture and constantly introducing new technologies, create needs for multidimensional competence of human resources. Therefore, it is necessary to transfer the best principles of decision support system to agricultural sector, apply new management styles and work methods. Modernization of human resources management applies to a variety of methodologies aimed at improving work efficiency by implementing the balance between the number of employees and the results achieved on time. *The purpose of the study* is *to analyse opportunities for digitisation of agricultural and rural development solutions*. The focus is on one of the options, the aim is to define how in a digital environment, using decision support systems (DSS), one employee can carry out several jobs and, according to feedback signal, perform their quality monitoring.

The research methodology is based on the management concept of human resources modernization, an integrated approach to decision support systems in the context of digitization of agriculture and rural development. Despite attempts to apply different contextual understandings of digitization to agricultural and rural development decisions, these studies have maintained the essentialist belief that the concept of a digital environment can be defined as a set of coherent essential properties and that these properties can be used as a basis for measurement and evaluation tools.

***Research methods*:** analysis and synthesis of scientific literature, conceptual modelling.

In this study, application of scientific literature analysis allowed the digitization process to be split into stages, to make changes to the constituent stages of the process and to make assumptions for the development of the model, and with the help of synthesis, to combine DSS principles into the model in pursuit of the best result. To achieve the goal, presentation of conceptual modeling as a process of problem situation modeling, i.e., how to perform several jobs with the help of robotization of possibilities of one worker and, according to the feedback signal, monitor their quality in a digital environment using DSS.

Theoretical part

Digitization of agriculture, as in other branches of the economy, which widely use

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modern technologies, largely depend on the quality of information technology, so such spatial information systems should be created, which allow constant monitoring of the changes taking place in the environment. According to Szafranska *et al*. (2020), in order to implement a coherent rural development policy in the region, the Polish and Ukrainian municipal institutions faced with the need to expand the existing system of spatial information infrastructure with elements related exclusively to agricultural research. For this, the concept of building an agricultural geodesy module as an element of the spatial information system of the region was developed, allowing continuous monitoring of changes in the environment. The implementation of climate and energy policy in Europe includes several development projects related to renewable energy sources. According to Kazak *et al*. (2017) the intuitive model supports communication with interested parties and helps to explain the links between human activities and the layout of power plants. The authors provide an overview of the research on the use of spatial analysis in the implementation of renewable energy policy and a proposal for the use of a multi-criteria spatial decision support system based on geographic information systems. According to Kazak & Świąder (2018), the goal of the implementation of energy development strategies is to create a decision support tool for solar radiation estimation, where the developed tool SOLIS is based on the existing ArcGIS algorithm by including input data conversion and result processing.

Farms use decision support systems that enable informed decisions to improve production and profits. For example, farmers can now use satellite imagery data to monitor surface temperatures in crop fields and other locations. Based Huang & Vatskel (2019) the use of GIS and GPS for efficient crop yield management and support of decision-making in agriculture increases the efficiency of operational management of crop areas. Li *et al*. (2021) identified several innovative practices in agricultural management: soil tillage, cultivation and manure insertion techniques.

In many countries, agricultural data platforms are being developed that collect and store data required to support precision farming decisions (Finger *et al*., 2019). IT management programs that cannot work smoothly, prevent the employee from managing modern devices or even damage them. Frequent jams can leave a robotic device without control, its activity can become unpredictable, which affects the quality of the work it performs and its safety as a mechanism. At the same time, it should be mentioned that a large role is given not only to the quality of IT, but also to the information communication channel through which an employee or other robotic devices can exchange information at a distance. Disturbances in such a channel can affect the quality of the work of the devices and the safety of the robotic devices themselves (Vuori *et al*., 2019). The basis for adopting precision farming and using decision support systems are data platforms that store data, enable data exchange between systems and provide decision support tools (Finger *et al*., 2019). These platforms are often developed by private companies or public-private partnerships.

Digitalization has created a new environment for business and public sector. Baležentis *et al*. (2021) propose an integrated approach to rapid decision-making in the agricultural sector, aimed at improving its resilience. Ambrasaitė *et al*. (2021) introduce the decision support system (DSS) COSIMA, which includes a combination of cost-benefit analysis and multiple-criteria decision analysis (MCDA) for transport infrastructure assessments covering both economic and strategic impacts. According to Anuziene & Bargelis (2007), it is very important that the competence of employees corresponds to the progress of information technology. For example, constantly updated framework of the DSS production system allows the DSS developer (applying technologies, devices, and processes) to choose the appropriate solutions

available in the network (platform) of partners' mechanical products. According to Al-nawayseh *et al.* (2013), the last mile logistics is one of the most important issues when buying goods online. To implement and evaluate this model, one of the available online routing and planning solutions is used (i.e., "*My route online*") to identify, analyse and compare the cost effectiveness of possible alternative delivery solutions. It is therefore concluded that the withdrawal point solution is the best logistics strategy to help online retailers. Irannezhad *et al*. (2020) introduce the prototype of the intelligent decision support system leading to horizontal and vertical cooperation between cargo agents involved in port logistics. The model presented by the authors combines optimization modelling and decision theory to operate in a dynamic environment characterized by information asymmetry between agents and dynamic changes over time. Coelho *et al*. (2021) introduce the developed simulation-based decision support tool for internal logistics, which analyses the activities that can take place in both the distribution facility and the production facility to achieve logistics 4.0. The developed models reflect reality and can be applied in various internal logistics environments, acting as digital twin tools to improve performance. Autonomous vehicle and spray control system developed by Cantelli *et al*. (2019) allows safe and accurate autonomous spraying operations. Giusti & Marsili-Libelli (2015) present a Fuzzy Decision Support System to improve the irrigation, give the information on the crop and site characteristics. According to Zhai *et al.* (2020), implemented advanced information systems with the help of internet technologies can collect, analyse, and process huge data, but (Ara *et al*., 2021) found that few DSS enable analysis of both tactical and strategic decisions, and that few DSS account for uncertainty in their outputs.) In order to address the challenges of digitization of agriculture more successfully, it is proposed to modernize human resources activities using DECISION SUPPORT SYSTEMS (DSS), develop robotics (Mohta *et al*., 2022, Cantelli *et al*., 2019), control the multi-functional processes, make changes to the process component stages according to the results obtained in order to achieve the best result.

Design part

In order to facilitate cooperation between a human (operator) and a robot in the environment of the agricultural sector, a human (operator) and a robot can be considered as resources capable of exchanging and (or) sharing tasks. As a result, the task can be assigned to both the operator and the robot (Nikolakis *et al*., 2018). A model of the implementation of the process of one worker's ability to perform multiple jobs with the help of robotization is presented, which shows the digitization of agricultural activities in the execution of tasks (Figure 1). Multifunctional sensor consists of climate, soil and Pest monitoring robots, their number is determined according to monitoring needs. DSS - computer-based decision support system, helps the operator to organize and carry out activities in a more objective, saving and sustainable way. A database (DB) is a set of normative and factual data, which is constantly replenished with new factual data.

Let's say the soil moisture monitoring system sensor records the lack of soil moisture. With the help of data on the internet, it sends a signal to DSS, which processes information and informs the operator about the situation in the serviced fields, calculates how much water it plans to pour, how much electricity will be consumed, when it plans to start watering the fields in order to normalize soil moisture. The operator can do nothing and the process, with the help of DSS, will begin at the scheduled time and with the intended means. Of course, the operator can either reject the planned procedure for watering the fields, or adjust it (in Figure 1, presented in blue. The command "Start" depends on the data received from the sensors). If the operator does nothing, watering process starts at the scheduled time. After pouring the estimated amount of water, the soil moisture monitoring system informs that the soil moisture meets the requirements, the process is assessed as successful. If, after

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pouring the intended amount of water, information is obtained that some area of the field has not reached the required level of humidity, the process is not fully successful, the operator can take following actions:

a) inspection of mechanical equipment;

b) verification of DSS process parameters;

c) targeted-partial repetition of the process.

The scheme represents how, in a digital environment, one employee can perform several jobs with the help of robotization and, according to the feedback signal, carry out their quality improvement.

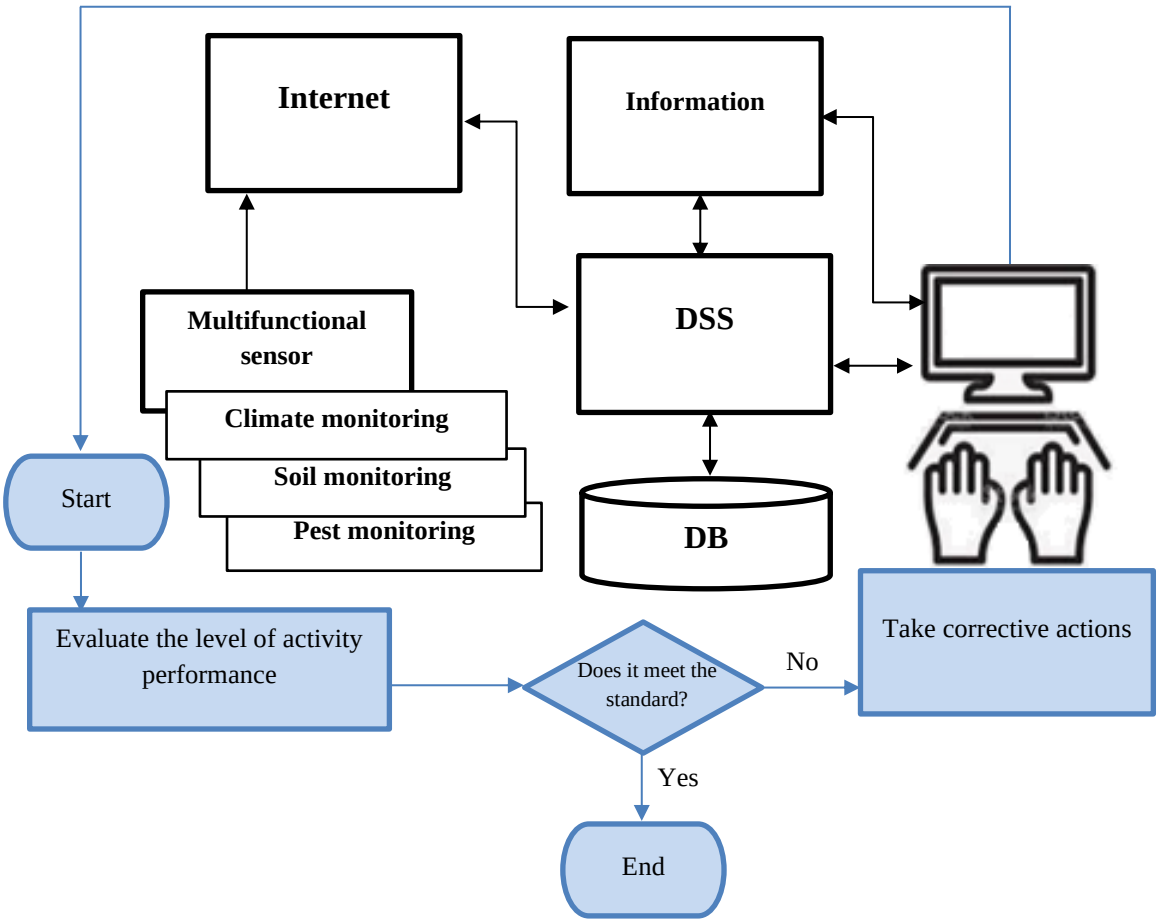

Figure 1. With the help of robotization of the capabilities of one employee to carry out several jobs and, according to the feedback signal, to carry out monitoring of their quality in a digital environment using DSS, conceptual scheme

Digitization of processes facilitates the work of human resources, simplifies operational control. The employee, having mastered the digital environment, is able to carry out and control multi-functional processes, according to the results obtained, to make changes to the constituent stages of the process in order to achieve the best result.

The model represents how, in a digital environment, one employee operator can perform several jobs with the help of robotization and perform their quality improvement according to the feedback signal.

Conclusions

Digitally generated knowledge and data in the field of agriculture and rural development are successfully archived and quickly found if necessary. With their help, analytical work, monitoring and forecasts can be carried out. This allows to make timely decisions that can increase work efficiency or reduce losses.

The developed conceptual activity scheme allows the operator / human resources to manage more than one activity process. The created scheme shows the possibilities for hybrid agricultural or rural development management work processes, which are more productive and will become a daily standard without losing control of their activities. The uses mobile multi-functional sensors that enable multi-parameter monitoring. The system allows you to use Narrowband IoT, as a result, mobile sensors consume significantly less energy, which increases the service life of the sensor battery, and data transfer to the data storage reduces the cost of communication using a narrow-band internet network. In terms of sustainability, the proposed conceptual scheme of activities allows for more optimal use of energy resources and conservation of nature thanks to DSS control, which allows the use of green electricity (solar, wind) when there is a sufficient amount of it and only switches to the global supplier network when there is a shortage. The created scheme does not tie a person (operator) to a specific (physical) place of work or activity, which improves the attractiveness of the workplace.

Every modern agricultural and rural development management system can ensure timely and high-quality work. With the help of internet technologies and robots, implemented advanced information systems (such as DSS) can collect, analyse and process huge data (metrological, soil conditions, market information, etc.), so one person can perform several jobs at the same time. An employee with the help of information technology can monitor and evaluate the processes of change in the agricultural and rural environment. Not all DSS are equally modern, allowing to analyse tactical and strategic decisions. In order to successfully address the challenges of digitisation of agriculture and rural development, it is proposed to facilitate cooperation between a human (operator) and a robot when they exchange and (or) share tasks, control multifunctional processes, and according to the obtained results, make changes to the components of the process in order to achieve the best result.

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