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Practical use of Agriculture 4.0 digital technologies to meet the EU's strategic goals in Czech agriculture

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Abstract

The implementation of precision technology procedures is declared in EU documents, including the implementation of these technologies in all areas of production, production, trade, including all areas of everyday life of the population. The article deals with the use of IT technologies in activities dealing with land management: i.e. crop production including landscape maintenance. In this context, precision technologies are used in agriculture, crop and livestock production, horticulture, forestry and comprehensive maintenance of the agricultural landscape. With remote sensing, all land areas are monitored, data is stored, and the whole process takes place continuously. The data is displayed in information maps that perfectly map the properties of the monitored area. Today, the development of the information society and specialized internet services of the state administration would not be possible without precise technologies and information portals. These are portals for the public needs of citizens or a specific professional community, and these must be user-friendly, clear, intuitive, visually interesting, trustworthy and complete in content. The article deals with a detailed analysis of the Czech Farmer's Portal from multiple angles, including state-of-the-art tools such as the AMS system (AMS, 2023). This is a new way of monitoring agricultural areas using a satellite system. On the basis of the analysed services, deficiencies are identified and suggestions for improvement are presented. .

Keywords

Information society, precision agriculture technology, eGovernment, Farmer's Portal, farmer, agriculture, SZIF, LPIS, single application, web application optimization, AMS system.

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Introduction

The implementation of precision technology procedures is declared in EU documents: e.g., 'Path to the Digital Decade Policy Programme (Decker and Okano-Heijmans, 2020), 'in all areas of production, production, trade, finance, management and will affect all areas of people's daily lives. The article discusses the use of IT technologies in activities dealing with land management: i.e. crop and commodity production, landscape maintenance, maintenance of forests and natural protected areas and reserves. According to the European Commission, this is the only way to guarantee the sustainable and harmonious development of natural capital in the common European space of the 'Digital Twin Transfer 2030' (Faraji, 2024). In this context, precision technologies are used in agriculture, crop and livestock production on farms, in horticulture, in forestry, and in comprehensive maintenance of the agricultural landscape. With the help of remote sensing (Sentinell, Copernicus, ...) the land areas are monitored, data on each m^2 of the land is constantly taken in layers (corresponding to different areas of the spectrum), the data is stored, the process takes place continuously throughout the growing season and dormancy. Other data is collected from sensors located at the border or directly on the property. Other volumes of data are processed using the so-called Big Data methods into information maps, which perfectly map the properties of the monitored area: moisture, presence of weeds, amount of fertilizers, etc. The information maps are then used by autonomous and robotic machines for precise interventions in the performance of operations: fertilization, harvesting, soil

amendment, soil quality, etc. Drones also monitor the soil and carry out some cultivation operations. It is expected that within 10-15 years, most of the operations will be provided and monitored by Artificial Intelligence (Sedláček, 2024).

Following the previous description of the development of the information society, it would not be possible without information portals and specialized internet services of the state administration. Any portal that is to serve the public needs of citizens or a specific professional community must be user-friendly, clear, intuitive, visually interesting, trustworthy and complete in content. The article deals with the analysis of the Czech Farmer's Portal from multiple perspectives of user activity. (analysis of graphic design, user experience, clarity, functionality) and the usability of the portal demonstrated on the example of electronic submission of a single application for a subsidy using the tools of the Farmer's Portal. One of the new features in 2024 is the AMS system (AMS, 2023). In 2023, for the first time ever, the State Agricultural Intervention Fund is introducing a new method of monitoring agricultural areas using a satellite system. From the English area monitoring system, we adopt the abbreviation AMS. This is a new way of checking whether agricultural activities have taken place on the monitored land in accordance with the legislation and have been met. conditions for the provision of the subsidy. Monitoring is carried out by the Sentinel 1 and Sentinel 2 satellites. Based on the results of the analyses, a description of specific problems was created with a recommended solution for further steps to improve them.

Materials and methods

The methodology of the article is based on the analysis of professional publications and information sources on the use of IT technologies in activities dealing with landscape management, land management, including business informatics. Subsequently, the article is elaborated on the basis of research in agricultural practice from the point of view of deploying portals, especially from the technological, functional and user point of view, using the following analyses:

- Serviceability Analysis (SUS)
- Qualitative research – focus groups and standardized interviews
- User Design Analysis (UXD)
- User Experience (UX) Analysis
- SWOT analysis

Farmer's Portal It is a single environment for submitting all applications and for accessing the registers of the Ministry of Agriculture published on the internet, which makes it a key tool for every farmer to carry out their activities (eAGRI, 2022). The portal is accessible through the website of the Ministry of Agriculture at: https://eagri.cz/public/web/mze/farmar/.

The basic core of the application consists of 3 registers: - Land Register – LPIS - Animal Register – IZR - Records of Preparations and Fertilizers – EPH These applications form the basis covering most of the farmer's user needs and also enable all legally required records to be carried out in electronic form. In addition to these applications, the Farmer's Portal also allows you to work in less frequent applications (eAGRI, 2022; Kubata, 2017): Portal applications are divided into public and non-public parts. All applications on the farmer portal should be fully compatible with most of the commonly available browsers. Apps for registered users are validated for compatibility with Microsoft Edge, Firefox, and Google Chrome (eAGRI, 2022). The SZIF Farmer's Portal is part of the SZIF paying agency (Havránek et al., 2013), which is responsible for the administration and payment of direct payments to farmers in the Czech Republic. The SZIF Farmer's Portal is closely integrated with the eAGRI Farmer's Portal (SZIF, 2023).

Usability Analysis – System Usability Scale (SUS)

Usability Analysis, also known as System Usability Scale (SUS), is a fast and reliable tool for measuring a wide range of systems, including applications, hardware, mobile devices, software, and websites. The system usability scale was invented by John Brooke in 1986 (Dunn, 2021; Hartson, 2012). The method is very useful as a basis for improving user experience and minimizing product development and maintenance costs (Nagar et al., 2022; Bruckner et al., 2012). It can also be used to compare the usability of different versions of a product or to compare the usability of products from different manufacturers (Špinar, 2004; Albert 2008) As part of the deployment of this method\ it is necessary to calculate the score of the evaluated product. The SUS score can then be used to compare the user-friendliness of products or services (Albert 2008).

The SUS score can be interpreted as follows:

- 90 and above: Excellent
- 80 – 89: Very good
- 70 – 79: Good
- 68 – 69: Above average
- 50 – 67: Average
- 49 and under: Bad

According to John Brooke, the average score of a compliant system is 68, and any lower value of the SUS score should be an impetus for product improvement (Brooke, 2013).

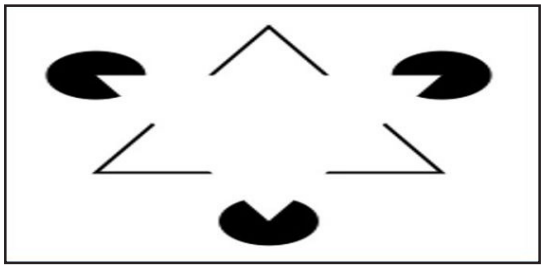
Qualitative Research – Focus Group

Thematic analysis is referred to as Focus Groups (Krueger, 2014).

A focus group is a research method that brings together a small group of people who answer questions in a moderated environment (Braun and Clarke, 2013). Focus groups are particularly suitable for collecting qualitative data (Tahal, 2022). Focus group analysis works with open-ended questions that examine users' attitudes, feelings, and beliefs, but also uses a series of questions designed to explore specific cognitive tasks related to information visualization systems (Krueger, 2014; Morgan, 1997; Walden, 2015). The premise of the method is that focusing the discussion on cognitive tasks allows to generate user comments that are more effective than informal and unstructured conversations

User Experience Design (UX design)

User Experience Design (also known as UX design, UXD, UED, or XD) is the process of defining the experience a user should experience when interacting with a digital product, website, product, or service (Marcus, 2014). The decision on a particular design within the design process should be guided primarily by research, data analysis, and user testing results rather than aesthetic preferences and opinions. Unlike UI design, which focuses primarily on the technical and graphic aspects of product design, UX design focuses on aspects of user perception of a product, such as its usability and usefulness (Marcus, 2014). The purpose of graphic design is to use visual elements such as colors, images, symbols, etc., to convey a message to the people who perceive them. Graphic design follows the laws of gestalt psychology and visual perception in order to create usable visual communication (Colascione, 2012) Shape psychology (also known as Gestalt psychology, Gestalt principles or Gestaltism) promotes the principle of wholeness. An example is the Kanizs triangle. This optical illusion vividly explains how the human eye and mind subjectively create or complete shapes where there are none. The constellation of objects in the image below leads our attention to the perception of a white triangle, which thus logically fills the missing space; however, no triangle is actually found in the Figure 1 (Cohen and Giangola, 2004).



The Kanizs triangle is a model used in the field of design and ergonomics to determine the ideal position of user interface elements. A triangle, figuratively speaking, consists of three elements: usability, aesthetics, and technical constraints (Cohen and Giangola, 2004).

Usability refers to the functionality of the user interface and how well users can interact with a website or app. It also includes making navigation easier and improving the user experience (Colascione, 2012; Cohen and Giangola, 2004; King, 2008).

Since web design is a broad term that encompasses all aspects of the human experience with a system, UXD also has elements that contribute to creating a positive user experience (Cohen and Giangola, 2004). In this evaluation context, we use the following elements (Spolsky 2001).

- Visual Design
- Information Architecture
- Interaction Design
- Usability
- Accessibility
- Human-Computer Interaction (HCI).

User Experience (UX)

User Experience (abbreviated UX) is the user experience or user experience that a website user has when using a website, portal or application (Nielsen, 2002) According to Albert Bill, UX is the process of measuring a user's interactions with the user interface and trying to evaluate them for future use. It also includes establishing policies

and guidelines that aid in the use of the digital product and its user flow (Albert 2008).

In their book The UX Book, Rex Hartson and Pardha Pyla cite the importance of UX as a crucial analysis for two main reasons. First, UX analysis helps identify existing flaws in a website or app. Second, UX analysis helps to better understand the terms that users are searching for, the parts of the site they spend the most time on, and the issues that need to be addressed as a priority (Hartson, 2012). Understanding user experience should be a top priority when designing and developing new applications, as it directly affects the success of the product through satisfaction (Albert 2008).

SWOT analysis

SWOT analysis (SWOT analysis) Strengths, Weaknesses, Opportunities and Threats) is a tool for identifying and analysing the strengths, weaknesses, opportunities and threats of an organization (Sedláčková, 2006). However, it can generally be applied to the analysis of anything, including web applications. The main objective of the SWOT analysis is to identify factors from both the internal and external environment that are involved in making key decisions (Tahal, 2022).

Information and digital literacy

Both concepts are intertwined and complement each other, but digital literacy is more specific and focused only on digital technologies. In today's digital world, digital literacy is very important and significant for many people to function successfully in both their personal and professional lives (Lauren and Lenna, 2021; Rivoltella, 2008; Samolienko, 2022) From the point of view of agriculture, Demet Soylu (2016) cites information need as satisfying the information needs of farmers, which results in an improvement in their efficiency and motivation A neutral definition was provided by UNESCO in 2018: "Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information through digital technologies for employment purposes in a secure and appropriate way, decent jobs and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy, including digital proficiency and digital awareness" (UNESCO, 2018; McFadden, 2022; Schallmo, 2021).

User interface

User Interface (UI) User Interface) is a place of interaction and communication between a person and a computer through a device. It can include display screens, keyboard, mouse, and desktop appearance. It is also the way the user interacts with the application or website (Spolsky, 2001; Cohen, 2004)

Information behaviour and information behaviour of farmers

Farmers need information about many factors influencing their activities, such as weather, soil quality, soil fertilization, soil preparation, seeds, pesticides and herbicides, crop growth, harvests, agricultural markets and many other areas (Narsh, 2017). Farmers also need to know about new technologies and practices that can help improve their yields and reduce costs. This may include, for example, information on new agricultural machinery, artificial fertilisers, new varieties of plants, and new methods of cultivation and harvesting (Wilson, 2000). As agriculture is very sensitive to changes in the environment and climate, farmers must be able to monitor and interpret information about climatic conditions in order to plan their activities and minimize risks. They need information about precipitation, temperatures, humidity, amount of sunlight, and other factors that may affect their crops (Sping, 2010). Nowadays, farmers are able to obtain information from various sources such as the Internet, educational courses, conferences, seminars and professional publications (Salampasis and Theodoridis, 2013). There are also specialized information systems that provide information on soil, weather, and other relevant areas of agriculture.

Farmers must have the ability to selectively search for information in order to acquire the necessary knowledge for their activities. They must be critical of the information they receive and assess it carefully to ensure that it is relevant and reliable (Narsh, 2017; Ostřížek, 2007).

Nowadays, it is important for farmers to be able to use modern technologies to obtain and process information. It is also important for farmers to communicate with other farmers, experts and institutions in the field who can provide useful information and advice. There are also various associations and organisations that provide advice, training and support for farmers (Fisher et al., 2006)

Optimization is the process of finding the best solution or the best possible result within certain constraints (King, 2023)

In the context of agriculture, it is important for farmers to optimize costs and increase the profitability of their crops. To do this, they can

use a variety of strategies such as selecting suitable crops, optimizing fertilization and irrigation, timely treatment of crops against pests and diseases, and effectively managing the storage and sale of products. There are many technologies that can assist farmers in optimizing their strategies and processes (Li et al., 2016). These include precision agriculture, which uses modern sensors, drones, and artificial intelligence to collect data on crops and soil quality, and then uses that data to enable more precise management of irrigation, fertilization, and pest and disease control (Pavlik et al., 2019; Stafford, 2005). Other technologies include, for example, applications for managing the storage and sale of products, automated machines for harvesting and processing crops, systems for monitoring the market and purchase prices of commodities, etc.

To optimize agriculture, the state-established agricultural Farmer's Portal provides services for the payment of subsidies, registration of land, animals, fertilizers and many others. With this platform, farmers can better plan their farming operations and optimize their practices to achieve maximum performance and minimize their costs. Portals for the disbursement of subsidies and land and animal records can also help farmers with administrative matters, allowing them to devote more time to the farming process itself. Overall, these portals can help farmers manage their farming operations effectively and improve the performance of their business. The main applications of the farmer portal are: Land Register – LPIS, Animal Register – IZR, Register of Preparations and Fertilizers – EPH, SZIF Farmer's Portal, Register of Hop Gardens, Vineyards and Orchards and others (eAGRI, 2023)

AMS system

One of the main tasks of the European Commission is the implementation of modern technologies in the field of agriculture. One of the typical examples is the novelty of 2023: the control of compliance with the rules of the single application using the AMS monitoring system. This system is more efficient and flexible than its predecessors. The European Commission is changing its overall position and, according to the new motto "prevention and communication", will first inform the applicant for inspections carried out when misconduct is discovered, before being penalized, and will create space for remedy without financial penalties (AMS, 2023).

AMS is working to evaluate remote sensing data using the Sentinel 1 and 2 satellites. On the basis of this data, it is possible to continuously monitor that the required agricultural activities are taking place according to the schedule. At that point, it has been proven that monitoring will provide the following identification (AMS, 2023):

- Agricultural Cultures
- Crop groups
- Mows
- Harvesting crops

For the future, new algorithms are envisaged to monitor additional conditions for uniform applications. Logging in to the AMS portal can be done in three ways:

Direct entry of the URL address A link on the SZIF website and a link to the Farmer's Portal

The AMS system, which remotely monitors the condition of the land, allows for a reduction in the number of time-consuming inspections for applicants of single applications and thus the obligation of their participation in the inspection. The evaluation by the AMS system can be continuously monitored for the applicant using an overview table of information on the status of compliance with the monitored conditions, on the progress of the administration of applications and on any requirements for the applicant's cooperation (e.g., taking a geotagged photograph). The table provides information about unmet conditions, undecided conditions, met conditions, and unevaluated conditions. For each of the conditions sections, we can click through to the list of relevant DPBs. The status of the monitored condition is interpreted using the traffic light, which is located on the left side of the screen. According to the colour of the traffic light, the applicant is informed whether the condition of compliance with the measures on one DPB has been met, in which case it is green, it has not been met, this is indicated by the red colour, in case a decision has not been made, it is orange in colour, or has not yet been evaluated and in this case it has a grey colour on the traffic light (AMS, 2023) (SZIF, 2024).

GTFoto

GTFoto, as stated (SZIF, 2023), is a web and mobile application for taking, sending, managing and evaluating geotagged photos for the needs of the AMS portal within the assigned tasks. The mobile app is available for users on two major mobile platforms – Android and iOS. It is used to perform tasks assigned by the SAIF

or to take separate photographs. These photos are then synchronized with the web application. Completed tasks and individual photos can be sent directly to the AMS portal from the mobile application. The GTFoto web application is used to register and manage mobile devices that will be able to take geotagged photos. Here you can delegate tasks to registered mobile devices, view photos and send completed tasks as well as individual photos to the AMS portal.

The data from the above research form the basis for proposals to improve the operation and better use of the Farmer's Portal.

Results and discussion

Research results to identify farmers' information needs

According to Pekařová (2023), the information needs of farmers differ for each of the farmers, depending on various factors such as age, education, experience in the field and also experience with information technology. Several interesting facts were found during the research. The most requested types of information that farmers most often seek are information concerning the income or expenditure side of their business and thus directly affecting their existence. The case study found that farmers mostly choose the Internet (i.e. they try to obtain information themselves) and discussions with other farmers known to them as the main source of information search – these two options were mentioned by 92% of respondents. The surveyed Farmer's Portal is only in 11th place (only a third of respondents mentioned it).

Results of the Serviceability Analysis (SUS)

Based on SUS analysis questions on 10 respondents, the SUS Farmer's Portal achieved a score of 60.75. This value indicates the Farmer's Portal as a system with an average level of usability. This means that it is in the range found in products that have a decent level of usability, but at the same time a lot of room for improvement. The result suggests that users were not entirely satisfied with its user interface, interaction, and overall user experience. The system certainly needs to be more user-friendly, intuitive and efficient.

Results of the qualitative research of focus groups

The conclusions of the survey in the form of a focus group (consisting of 10 farmers) relate mainly to impressions of the Farmer's Portal, its functionality, appearance and negative or positive experiences when working with it. The findings show the following findings. Farmers use PF for their work on average 3 to 4 times a month. Most of the users commented on PF as a very counterintuitive system that is hardly used without technical support. They rate working with PF as lengthy and even after years of use, their work with the application is not automatic. Eight out of ten respondents agreed that PF makes their work easier. Not one in 10 farmers works completely independently at PF. Suggestions for improvement: From the free discussion of the focus group, the most frequent suggestions for improving the PF were the personalization of the content or the interconnection of the PF with the Czech Statistical Office for the purposes of data collection and submission of mandatory statistical reports. Respondents would welcome it if, based on the stored user ID, after logging into the system, they could only see applications and activities that they normally use or that result from the nature of their agricultural production (animal vs. plant). For example, farmers who do not do business in the field of viticulture or orchards would not be able to see the Vineyard Register and the Orchard Register.

Results of the User Design (UXD) Study and User Experience of the Farmer Portal Homepage

Key comments about the PF UI:

- It doesn't have its own established logo
- Inconspicuous placement of a tile to click through to the SZIF portal
- The news section is not visible on the home page, but you need to scroll down the page
- News for each application separately (and not one central section)
- The graphic design and layout do not correspond with individual sub-applications (e.g., with the Farmer's Portal LPIS, PF IZR, etc.)
- The main page is filled with a wide range of confusing information
- The left navigation menu, as the main navigation menu of the site, is in small font and has items too densely packed on top of each other, in addition to having 23 items
- The pop-up signpost does not comply with the principles of creating a website, because it unexpectedly pops up and covers the navigation menu

- Small font size for headings and subheadings
- All headings and subheadings the same size
- Non-separating main headings from subheadings
- Ambiguous bookmark names
- Lacks contextual help for bookmarks and app features

Suggestions for improvement: Create a distinctive logo specifically for PF; unify the graphic design of all parts of the website; cancel the pop-up signpost (or at least prevent it from popping); condense the left navigation menu by grouping similar items; introduce context-sensitive help for menu items, icons, functions, bookmarks and subtabs; put the news in a visible place; replace the auto-expanding signpost with click-to-click expanding; separate parent and child items with an adequate font size and indent items from each other; call menu items, functions, and buttons concise and unmistakably with other menu items; provide context-sensitive help for all clickable options; Place the SZIF click-through tile at the top of the home page so that it is quickly available and provide the tile with a label, e.g. switch to PF – SZIF.

Results of the analysis of the design and user experience with the LPIS Land Register

- Absence of contextual help (especially for light bulbs)
- Important buttons for back-and-forth confirmation and switching are missing - Soil Register Application - LPIS)
- Missing navigation to next steps
- Non-contrasting color differentiation of buttons and menu items
- Unclear controls such as light bulbs, drawing tools, and map field controls and elements
- The button to invoke the action P = PREPRINTS is too small
- Insufficient size of tables, forms, and information fields relative to the size of the monitor resolution (too many tabs are not visible)
- Map field tools are fixed in the map, the panel cannot be moved and thus covers the part of the map field that the user needs to see for his work
- Tables, windows, and information boxes don't appear with all tabs, some of them remain hidden
- The navigation arrows for scrolling between tab names blend with the bookmark names
- Tables and windows within the dataset editing have only a magnifying glass icon available to return to the map field

Suggestions for improvement: Choose a more appropriate color contrast; provide the bulbs in the application with clear contextual help (e.g., a speech bubble); use uniform drawing tools; Adjust the size of the user interface to the size and capabilities of conventional monitors. highlight important buttons in color, preferably with red text or red outline of the button (or at least important buttons); Buttons and radio buttons could blink if this is the only or last step to complete the window, application, or form. for the map field control ribbon, allow the drawing tools panel to move to a different location on the map. highlight navigation arrows used to move between menu tabs (e.g. in deep yellow); label the item Soil preprints with the name Preprints, not just the letter P; the magnifying glass icon is too small due to its importance (it takes the user to the map drawings necessary for the submission of the JŽ), it is recommended to leave the magnifying glass, but with the addition of the "Map field" label and the use of context-sensitive help again.

Results of the study of user design and user experience with the Integrated Agricultural Register of the IRR

- At first glance, it is not clear that this is a register designed to register animals
- The IZR notice board has an unsatisfactory font size, the selected colors are not very contrasting and individual items disappear
- The icon to start the registry itself is drowned in the number of windows
- The navigation menu is also lacking in contrast and clutter
- Headings and subheadings are not differentiated
- The field of the animal registration record extends far beyond the display capabilities of monitors in terms of width and height
- A large number of inappropriately placed functions
- The IZR notice board and the selected colours have little contrast and individual items disappear
- The underlined inscription Register is not clickable
- Menu items are packed close together

Suggestions for improvement: Add the word "animal" to the name of the Integrated Agricultural Register to make the purpose of the IRR clear; create a more modern and user-friendly menu, which will have a clearly set and noticeable hierarchy of items and tabs (change of font, font size); Adjust the size of the user interface to the capabilities of commonly used monitors to ensure that all the items offered by the system are displayed; Combine functions for working with the animal registry into sections, e.g. animal numbers, animal movement reporting, ear tags, green diesel, etc. These sections would include other more detailed options; choose a more suitable color contrast, more saturated green colors and larger spacing between items in the left menu will add clarity; highlight the registry launcher, enlarge it and name it "Start Registry"; Create an overview of recordings that does not extend beyond the edges of the monitor and allows users to see all attributes of the recording.

Results of SWOT analysis

The positive aspects of the Farmer's Portal are its individual applications. The portal offers farmers a number of useful features, such as access to the system from anywhere and at any time, the ability to use the system without the need to install hardware or software. However, the high password requirements and password recovery process are difficult and inconvenient for farmers. A proposal to improve the situation with the password is that the Farmer's Portal offers the possibility of automatic generation of forgotten

passwords and identity verification via email and mobile phone (double identity verification).

This suggestion will surely help improve the user experience of farmers.

Another strength of PF is the high level of technical support and quick resolution of any problems, but only during working hours. The manual is also very detailed and well done, but its large scope can be challenging for some farmers. However, instructional videos are a faster and more effective option to learn how to control PF. The efficiency of PF control is a weakness of the system, which is largely due to the complexity and large number of functions. However, most farmers are satisfied with the technical support and added value that PF brings.

Farmers see the emergence of a community of virtual users as a possible opportunity. A key threat is the lack of computer literacy of users. This prevents the efficient use of technology and digital data processing, which are important aspects for the successful operation of modern farms today. It is important to remember that increasing computer literacy and technological knowledge is not an easy process, especially for people who do not have much experience with digital technologies. It is therefore necessary to ensure that farmers have access to quality training programmes that will enable them to acquire the necessary skills.

Finally, psychological obstacles, such as fear of technology and lack of confidence in one's own abilities, should also be mentioned. These factors can hinder the effective use of technology and the acquisition of computer literacy. Therefore, training programs should be aimed not only at acquiring technical skills, but also at providing psychological support to farmers and increasing their self-confidence in this area.

Evaluation of the AMS system

According to Sedlacek (Sedlacek, 2024), the analysis of the AMS case study and the first user experiences, as well as the evaluation of the SWOT analysis, shows a comprehensive view of the functionality, advantages and challenges of the Automatic Monitoring System (AMS). The research was carried out in 5 companies

Summary of results:

- All companies have demonstrated a high degree of compliance with the conditions of JŽ according to the AMS assessment.
- The results show that the AMS is an effective tool for monitoring and evaluating compliance with agricultural conditions.
- None of the companies surveyed had any red or orange alerts at the end of the reporting period, indicating that they had successfully responded to any issues identified by the AMS.

AMS SWOT analysis

Strengths: Automation and increased efficiency, accurate data for better decision-making, effective tracking and analysis, easier JS management.

Opportunities: Technological advancements, regulatory compliance, reduced inspection burdens, improved user experience.

Weaknesses: Need for training and adaptation, dependence on technology, ensuring security and data protection, technological equipment.

Threats: Problems of interconnection of information systems, social and ethical issues, risk of poor decision-making processes.

Suggestions for AMS improvements

Suggestions for improving the Automatic Monitoring System (AMS) may include the following aspects. Implementing advanced technologies to better detect and analyze data, e.g. using AI and machine learning to improve the interpretation of satellite imagery and other inputs. Ensuring that data is regularly validated and updated to ensure that it is as accurate and up-to-date as possible.

Another suggestion is to work on an interface that is as intuitive and user-friendly as possible, which will be easy to understand for all users, regardless of their technical expertise. Simplifying the process of filing additional evidence and change requests. Possibility of adapting the system to the specific needs and requirements of different types of farms. Introduction of additional features, such as predictive analytics, or automatic notification of potential issues. Enabling better integration with other agricultural and government information systems for data and information sharing. Establishment of a mechanism for collecting feedback from users and using it for continuous improvement of the system. Regular evaluation of the use and impact of the system on agricultural practices and conditions. These improvements could lead to a more efficient and user-friendly system that better meets the needs of farmers and regulators, while ensuring a high level of data accuracy, security, and reliability.

Conclusion

The analysis of the Farmer's Portal was carried out from two main points of view – the visual aspect (i.e. design) and the user experience of a selected group of farmers who have been doing business in the field of agriculture for many years. The output of the detailed analysis of the Portal are specific optimization proposals for improving and making the application more transparent, which can be found in Chapter 6 of the thesis. Several relevant methods of quantitative and qualitative analysis were used for the analysis – questionnaire survey, usability analysis (SUS), focus group research, design analysis (UED) and user experience (UX) and SWOT analysis. A case study conducted on a group of 85 farmers revealed that farmers most often search for information about the purchase prices of their products and the weather, the main source of information for them is the Internet and they most often search for information using their mobile phones as an information medium.

The quantitative analysis of the usability of SUS showed only an average usability score of the Farmer's Portal, which points to a lot of room for improvement in the usability of the system towards simplification, clarification and greater intuitiveness. Specific suggestions for improvement are outlined in Chapter 6. The analysis of the design and user experience (UX) then made it possible to obtain qualitative data on the preferences and needs of the users and helped to identify the key elements for creating a user-friendly, visually appealing and effective website, which can be found again in Chapter 6 The conclusions made from the focus group's research were very helpful in this regard. All respondents agreed that the Farmer's Portal is a very confusing, confusing and counterintuitive application, which they hardly use without technical support or the use of the services of one of the consultants. Work in it is tedious, slow. The graphic design is bland (each sub-application has its own design), the layout of the individual menu items and tabs is cluttered and gives a feeling of being lost, which is partly due to the small size of fonts, headings and the absence of accent elements. This was confirmed when determining the strengths and weaknesses of the Farmer's Portal based on a SWOT analysis, which also contributed to a comprehensive picture of this website. All specific findings, suggestions for improving the application can be found on the pages in Chapter 6. Based on the collected data and information, a number of optimization changes to the Portal were proposed in order to increase user comfort and experience. These changes included improvements to navigation, the overall layout of elements on the page, improvements to the content structure, greater personalization of content, unification of the graphic designs of the main page and its individual subsections, and the addition of other useful features. The latest AMS application was evaluated in detail with the following commentary on the evaluations. The main benefits of the website include increased efficiency and productivity, better data analysis, decision support, and improved coordination and communication. Furthermore, these conclusions in Chapter 6 point out that, despite some weaknesses and threats, such as lack of training, reliance on technology, cybersecurity and data leakage, IS integration and AMS overall contribute to better management and management of the farms under review. Designed to monitor and evaluate compliance with agricultural conditions, the AMS system has proven to be an effective tool.

Its colorful traffic light system and alert response capabilities allow for efficient management and quick response to potential issues. The results of the monitoring showed a high degree of compliance and efficiency of the use of AMS.

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