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Impact of low code development in organizational software: the case of Soc.Agr Porto Muge

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Dissertation

presented as partial requirement for obtaining the Master Degree Program in Information Management

NOVA Information Management School
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IMPACT OF LOW CODE DEVELOPMENT IN ORGANIZATIONAL SOFTWARE: THE CASE OF SOC.AGR PORTO MUGE

By

Pedro Miguel Ferreira Vicente

Master Thesis presented as partial requirement for obtaining the master's degree in information management, with a specialization in Knowledge Management and Business Intelligence.

Supervisor/Orientador(a): Pedro Malta

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

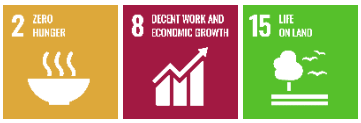
ABSTRACT

This study investigates the impact of a mobile application developed using OutSystems and an agile methodology on an agriculture company. Employing a qualitative approach, we conducted separate focus group sessions, one with application users and another with OutSystems developers. Thematic analysis was utilized to assess the application business benefits and development quality. Findings reveal significant improvements in the company's operational processes and efficiency, reducing paper and know exactly when to treat the crops and what product to use with implications for enhanced future production, with less chemicals used. Developers identified minor areas for improvement on the code with major concerns about performance as the application gets more data. This study highlights the potential long-term effects of data accumulation on company performance. Both of groups reported that would be useful offline capability to the application and effective training on new users on the app. Future research should explore the sustained impact of the mobile application in the context of the agriculture company with the added improvements suggested by the users and developers.

KEYWORDS

Agriculture; OutSystems; Mobile; Agile

Sustainable Development Goals (SGD):



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LIST OF ABBREVIATIONS AND ACRONYMS

IT	Information Technology
PaaS	Platform-as-a-Service
LCDPs	Low-code development platforms
IL	Integration Language
API	Application Programming Interface

1. INTRODUCTION

Information technology systems are a very important piece of technology in companies that create opportunities and options that did not exist before, companies that understand that will continue to differentiate from others and reap economic rewards (Brown, 2003).

According to a National Statistics Institute (INE, 2022) survey, 86% of Portuguese businesses with ten or more employees had an internet connection in 2021, and 93% of them utilized computers. Also states that the most common IT applications used by Portuguese enterprises are Communication and collaboration; Customer relationship management; Enterprise resource planning; Data Analytics.

There are several advantages for Portuguese businesses in using IT. IT can assist businesses in being more competitive, efficient, and cost-effective. For instance, an IT-using business is more likely to be an exporter and to be more productive.

In agriculture new methods and techniques are emerging using IT systems. The application of technology to control variability within fields is known as precision agriculture. Sensors and human inputs on digital systems can be used to gather information on agricultural yields, soil conditions, and other variables. An algorithm may be used to analyze this data and produce more accurate input values for pesticides, fertilizer, and water usage. This can assist in raising output, cutting expenses, and lessening the company's environmental impact (da Silveira et al., 2021)

Sociedade Agricola Porto de Muge is a small agricultural company that does not have any IT technology to help with company management. Creating software that fits the organization's needs will for sure improve the company's performance.

What is the impact of digital transformation? In a company that is in the first face of digital transformation “Business as usual“, what would be the impact of trying to improve some processes with IT System to push the company to the second phase of digital transformation, “Present and Active” (Verhoef et al., 2021) (Schwertner, 2017).

It is exceedingly difficult to operate a firm in a safe and sustainable way these days since everything related to people, processes, and stock is managed on paper, often even without any notes at all. "Agrisoft" is an Outsystems application designed to solve the issues and assist the organization in resolving this problem.

This application will be composed of two modules of software that will be developed following the best practice of UI/UX and Outsystems. These two modules, employee management and agriculture fields will provide valuable information to the company to make the right decision and move the company forward. So “Is it possible to build software using a tool, p. ex. Outsystems, to improve some processes in the company and then measure its impact on the company’s performance?”

OutSystems, when compared to alternative low-code platforms and conventional development techniques, is an excellent low-code development platform, and is the best option for developing applications. This finding is reinforced by a thorough examination of several important variables.

Primarily, OutSystems excels in terms of development speed, with studies by Forrester Consulting indicating it can deliver applications up to ten times faster than traditional development(The Forrester

WaveTM:, 2023). In addition, OutSystems is acknowledged for its cost-effectiveness. Because of its scalability, which is the result of a strong microservices design, it may be used for projects of any scale.

Finally, OutSystems is a leader in The Forrester WaveTM study (The Forrester WaveTM, 2023) demonstrating its commitment to innovation. Together, these crucial characteristics make OutSystems the go-to option for businesses looking for creative, quick, scalable, and affordable application development solutions.

To gain better insides on what IT systems can build with Outsystems, a Study Case methodology will be used: Sociedade Agricola Porto de Muge will be the case to study. A qualitative approach to collect data using two focus groups to understand the benefits of the IT systems. One of the focus groups will be done with Outsytems developers to understand the quality of the application and the other one with application users and future users to understand the impact on the business.

At that moment the company uses an archaic methodology to manage the employee and the agricultural fields using paper to store information. The main expected contribution would be to centralize this information in an IT System that is easy to access, intuitive and easy to use. Therefore, minimize human error which with the current system is much more likely to happen.

2. LITERATURE REVIEW

2.1. AGRICULTURE 4.0

Since the beginning of time, humans have bred animals and farmed areas to provide food for their survival. Agriculture has changed from Agriculture 1.0 to 4.0 throughout the course of a lengthy and gradual process (Tekinerdogan, 2018). Agriculture 1.0 began with animal power then Agriculture 2.0 was defined by the combustion engine. As military GPS signals become widely available to the public in recent years, agriculture 3.0, which started with guiding systems and precision farming and nowadays, Agriculture 4.0 farm activities are connected to the cloud (Marucci et al., 2017).

Based on a concept for future production, the agriculture 4.0 development occurs concurrently with similar evolutions in the industrial sector. Like Industry 4.0, Agriculture 4.0 refers to the internal and external interaction of farming operations and provides digital information for all farm sectors and activities. The 4.0 revolution gives a fantastic chance to think about the unpredictability and uncertainties that are involved in the agri-food production chain, not just in the industrial sector but also in agriculture(Deichmann et al., 2016; Van Rijswijk & Frewer, 2012). The combination and integration of industrial technologies and devices, information and communication systems, data and services, and network infrastructures results in smarter, more efficient, safer, and ecologically sustainable factories(Adnan et al., 2018).

Agriculture 4.0 is portrayed in a number of studies as a potential solution to a number of issues that existing agri-food systems face, with an emphasis on its potential to boost agricultural productivity, cut production costs, combat climate change, and possibly enhance food security(da Silveira et al., 2021). In several of this research, resources associated with Agriculture 4.0 are envisioned as tools that, when included into production procedures, can raise the level of agri-food systems intelligence. Chrysanthi Charatsari (2020) said that this type of agriculture has the power to substantially modify the structures, objectives, aims, and operational paradigms of extension organizations by giving advisers new socio-technical responsibilities and changing the settings in which they work and live.

The purpose of this document is to demonstrate how low code development and agile methodology may help an agriculture company grow from the earliest stage of agriculture 3.0 to agriculture 4.0, also improving its digital maturity to keep up with the world change and evolution.

2.2. DIGITAL TRANSFORMATION

Digital Transformation is a process with the objective of creating or modifying existing business processes, change culture, increase productivity and improve customer experience using disruptive technology (Ebert & Duarte, 2018), in order to observer the growth of digital maturity, Pihir (2018), learned that it requires five crucial steps:

- Customer centricity.
- Strategic orientation.
- Talent.
- Process infrastructure.
- Capability/capacity.

- Strengthening.

~~W~~ with the aim of improving the digital maturity of the company.

Digital technology has a significant impact in the world's economy and society, that change demands that companies implement digital strategies and adjust their focus to build different and robust business models to fulfill their businesses. To keep up with this evolution and implement digital strategies being up to date with new trends in innovative organization culture, take advantage of new technology software and hardware is essential to gain competitive advantages, such as increased sales, efficiency and customer-centered focus, resulting in innovations in value creation or new forms of customer interaction (Hrustek, 2020; Lammers et al., 2018). This transformation is unavoidable in the needs of any business seeking for growth, expansion, quality, and sustainability (Shinde et al., 2014).

2.2.1. Digital Transformation in Agriculture

Growing global warming, coupled with unpredictable weather, unstable markets, a lack of human resources, and the high cost of both human and material resources, provide a significant risk and uncertainty for farmers (Lammers et al., 2018). As a result of these changing trends, digital technologies are surpassing human capabilities, even in tasks that do not directly follow existing rules and could not previously be automated, such as communication and pattern recognition in changing, uncertain environments(Yahya, 2018). A lot of technology has been used in agriculture in the past, but it has been limited and mainly focused on the sustainability of the agriculture industry until now. In the future, the agricultural industry will be able to meet the challenges of sustainability using smart digital services that can help it meet the challenges (Hrustek, 2020). As computing capabilities grow exponentially, smart solutions will become more affordable and more readily available on the market, and by 2025, the mobile Internet, knowledge automation, and the Internet of Things will generate up to $33 trillion in economic value (Yahya, 2018). Also, by that year, precision agriculture market is expected to generate revenues more than $12 billion, with a growth rate of 15%. A growing market will result from the increasing application of smart agricultural practices. This will be due to advances in management algorithms, big data, digital technology, and the integration of renewable energy systems. According to projections, managed precision agriculture services will increase by 27% from 2019 to 2025.(Bersani et al., 2020)

2.3. LOW CODE

Kanji and Wallace (2000) said customer satisfaction is the biggest factor for business success with that in mind low code is without a doubt one of the technology trends of the last few years that meet this objective.

As part of the Platform-as-a-Service model (PaaS), Low-code development platforms (LCDPs) can be developed and deployed on the Cloud, enabling the development and deployment of fully functional software applications utilizing advanced graphical user interfaces and visual abstractions that require very small or no procedural code to operate(Waszkowski, 2019).

LCDPs enable end users with no programming background (called citizen developers) to contribute to software development processes without sacrificing the productivity of professional

developers, because of the shortage of highly skilled professional software developers. It is very versatile in its applicability and can be scaled both for small companies and teams and for organizations with a much larger and more demanding structure, providing both long and short-term solutions. With low-code platforms, citizens can build their software applications without the support of developers who previously worked on full-stack development of fully operational applications. This allows developers to concentrate on the business logic of the application rather than worrying about setting up infrastructures, managing data integrity across environments, and enhancing robustness(Bock & Frank, 2021). Bug fixing, application scalability and extensibility are also made easy, fast, and maintainable in these platforms using high-level abstractions and models. Furthermore, procedural code can be defined in these platforms to further customize the application according to the client preferences. In a study conducted by Carl Lehmann (2018) with 451 researchers it was concluded that low-code platforms enabled improvements to be achieved in haft of the time than classical coding languages. Additionally, this reduces the cost of human resources, which are important in the field of computers, but are extremely expensive for businesses. To put it simply, it reduces the initial installation, training, distribution, and maintenance costs (Sanchis & Poler, 2019).

Lastly, LCDPs has as the main objective make less complex the development and scalability of organizational software and not to reduce the importance of the developers but taking advantage of their knowledge to create high quality applications.

Why OutSystems? Outsystems is the greatest low-code development platform and the finest choice for creating apps when compared to other low-code platforms and traditional development methods. Numerous significant factors are thoroughly examined, which supports this finding. Forrester Consulting tests show that OutSystems can provide applications up to ten times faster than conventional development, which is the main area in which it shines (The Forrester WaveTM, 2023). Furthermore, OutSystems is recognized for its affordability. Its scalability, which comes from a solid microservices design, allows it to be applied to projects of any size.

2.3.1. Outsystems

OutSystems is a low-code development platform that enables customers to create and deploy unique, enterprise-grade online and mobile apps rapidly and easily. A computer language called "Integration Language" (IL) is used to handle business logic and data integration, and a visual drag-and-drop interface is used to develop user interfaces (Outsystems, 2022).

By drastically lowering the amount of code that must be produced, one of the key advantages of adopting OutSystems is the potential to speed the development process. This makes it a desirable alternative for businesses trying to quickly create and deploy apps since it may save time and resources(Huff, 2019). Along with these additional capabilities and integrations, OutSystems also provides support for AI and ML, a user management system, and compatibility with well-liked cloud platforms like Amazon Web Services and Microsoft Azure. OutSystems adheres to industry best practices for security and has numerous layers of protection to guard against potential attacks. It also adheres to a stringent security development lifecycle and provides frequent security upgrades(Outsystems, 2021).

Overall, OutSystems is a strong and adaptable platform that can speed up the creation and rollout of bespoke apps for businesses while also providing strong security features to guard against attacks (Vicent Paul et al., 2022).

2.4. AGILE

The expression “Agile methodologies” became known in 2001, when experts in processes of software development representing, among others, the Scrum framework and Extreme Programming framework merged the main concepts and qualities of them. Thus, the agile alliance was created and therefore the agile manifesto was established (Fowler & Highsmith, 2001). From this document, agile methodologies became recurrent in the software development world in a rapidly evolving environment, existing different agile methods/frameworks that have a lot in common, like small iterations, constant interaction with all parts involved in the project and continuous learning, the most used among them being Scrum (Wang et al., 2012).

Manifest for Agile Software Development is composed by four essential values (Highsmith et al., 2001):

- Individuals and interactions over processes and tools;
- Working software over comprehensive documentation;
- Customer collaboration over contract negotiation;
- Responding to change over following a plan.

And stands in twelve principals:

- Our highest priority is to satisfy the customer through early and continuous delivery of valuable software;
- Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage;
- Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale;
- Businesspeople and developers work together daily throughout the project;
- Build projects around motivated individuals, give them the environment, and support they need and trust them to get the job done;
- The most efficient and effective method of conveying information with and within a development team is face-to-face conversation;
- Working software is the primary measure of progress;
- Agile processes promote sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely;
- Continuous attention to technical excellence and superior design enhances agility;
- Simplicity—the art of maximizing the amount of work not done—is essential;
- The best architectures, requirements and designs emerge from self-organizing teams;
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

2.5. BENEFITS OF LOW CODE FOR AGRICULTURE

In the context of agriculture, which refers to the use of digital technology and data analytics to increase the production and efficiency of the agricultural industry, low code development can be very helpful. Here are the ways low code development can help improve the five crucial steps by Pihir (2018) mention in the section 2.2:

- **Customer centricity:** Agricultural businesses may more readily create custom software solutions with low code development that cater to the unique requirements of their clients, whether they are farmers, food processors, or consumers. For instance, an agricultural organization may employ minimal code development to create a unique app for farmers that aids in crop tracking and management or create a unique solution for food processors that aids in supply chain optimization;
- **Strategic orientation:** By enabling agricultural businesses to construct and deploy customized solutions that meet new opportunities or issues as they occur, low code development may help them remain ahead of the curve rapidly and easily. An agricultural company, for instance, may employ low code to create a tailored solution that enables them to react to changes in consumer demand or market;
- **Talent:** Low-code enables agricultural businesses to utilize technology and tools more effectively, enhancing their operational efficiency, enabling them to make data-driven choices, automate tedious processes, and optimize their process infrastructure. An example would be a creation of knowledge sharing applications and collaboration applications that can make easier for different departments and stakeholders within an organization to collaborate and share information, which can improve communication, productivity and streamline the decision-making process;
- **Process infrastructure:** In the agriculture sector, low code development may speed up the software development process, requiring less time and money to provide new solutions. As a result, agricultural organizations may be able to increase productivity and efficiency of their total process infrastructure;
- **Capability/capacity:** Low code development can help agricultural organizations scale their custom software development efforts, allowing them to keep up with changing business needs and demand more easily. This can help them improve their overall capability and capacity and stay competitive in an increasingly digital agriculture industry.

In conclusion, low code development can be an effective tool for improving various aspects of businesses, including customer centricity, strategic orientation, talent, process infrastructure, and capability/capacity by developing/changing applications in a much quicker way (Carl Lehmann, 2018). It can be particularly useful in the context of agriculture 4.0, helping agricultural organizations optimize their operations and stay competitive in an increasingly digital industry.

3. METHODOLOGY

In order to analyze the effects of low-code development in organizational software within the context of Soc. Agr. Porto Muge, this study utilizes a Study Case research approach (Yin, 2003). The case used will particularly highlight an application created for the company in study utilizing OutSystems. The method enables an in-depth investigation of a particular project and offers a thorough grasp of the real-world application of low-code development in a practical situation. Two different focus group sessions will be used in this research to gather pertinent data (Baxter & Jack, 2008; Conboy et al., 2012). Farmers and corporate personnel that engage with the app daily will be included in the first focus group of app users. OutSystems developers who did not participate in creating the application will make up the second focus group to give useful feedback on the application code. This strategy will give developers and end users perspectives, enabling a comprehensive evaluation of the application's impact. Depending on participant preferences and practical concerns, the two focus group meetings will be held separately in a relaxed and private setting, the one with the users of the application will be held in person and the one with the Outsystems developers will be online. It is anticipated that each focus group session would run between 30 to 60 minutes.

The following topics will be covered in the users group:

- User Experience: Understanding the usability, intuitiveness, and satisfaction with the application's user interface;
- Impact on Workflow: Assessing how the application has affected the efficiency and effectiveness of daily tasks related to agriculture activities;
- Benefits and Challenges: Identifying the advantages and drawbacks of using the low code developed application in comparison to traditional software solutions;
- Suggestions for Improvement: Gathering feedback and suggestions from users to enhance the application's functionality and user experience.

For Developer Focus Group For the developer focus group, the following topics will be addressed:

- Code Review: Evaluating the code quality and the application global architecture;
- Best Practices: Assessing the maintainability, scalability, and adherence to best practices in the application's codebase;
- Challenges and Pain points: Gathering feedback on the ease of development, available tools, and resources provided by the OutSystems platform;
- Suggestions for Improvement: Collecting ideas at a brainstorming session to improve the developer experience and the quality of the code.

The focus group data will be transcribed, then thematic analysis will be employed to analyze it. To acquire a thorough knowledge of the effects of the low code produced application on the company, themes and patterns will be found in the replies of the participants in each focus group.

As a Study Case, the results of this study might not be very generalizable to other situations. Furthermore, focus group data's subjectivity may add unintended biases. Nevertheless, the study's validity and reliability will be improved by the inclusion of diverse data sources, including user input and developer viewpoints.

This study seeks to give useful insights into the influence of low-code development on the organizational software application, helping to analyze its advantages, difficulties, and overall quality. It does this by using a case study approach and by holding two different focus group sessions. The research can advance knowledge of low-code development in organizational software and provide useful advice for initiatives that may be comparable in the future.

4. EMPIRICAL STUDY

This application was made with the intention of streamlining some of the business processes both now and in the future and aiding in decision-making for similar jobs. Six two-week sprints were used to construct the application in OutSystems using an agile methodology.

The initial planning was:

Sprint 0 – Application architecture and database definition;

Sprint 1 – Backoffice application;

Sprint 2 – Homepage; Employee List/Add/Edit; Fields List/Add/Edit;

Sprint 3 – Products List/Add/Edit; Crops List/Add/Edit; Sub-Fields List/Add/Edit; Pest List/Add/Edit;

Sprint 4 – Task List/Add/Edit;

Sprint 5 – Purchase List/Add/Edit;

Sprint 6 – Application Improvements.

This plan was based on the database on user's feedback, trying to prioritize the mission critical functionalities that were need to the business.

4.1. DEVELOPMENT

4.1.1. Sprint 0

This one-week pre-project "sprint" was used to meet with the app's potential customers to gather the key feature requirements based on which the application architecture was established, and the first stage of the relation database was built. Regarding the functionalities the users requested a page where they could enter the costs/purchases that their firms made as well as a mechanism to record tasks they completed in the fields with a high degree of detail. After refining, the requirements a first phase of the database diagram and the 3-layer canvas were made.

The last versions of the 3-layer canvas and the database diagram are show bellow in Figure 1 and Figure 2.

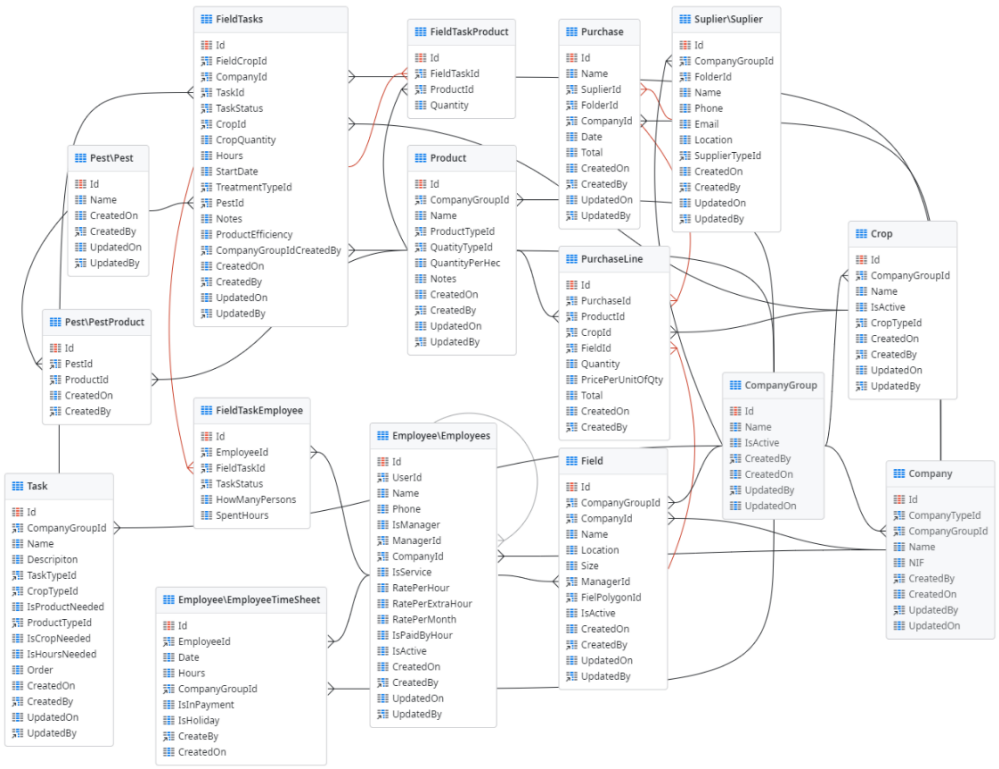

Figure 1 - Database Diagram

Figure 2 - 3Layer Canvas

4.1.2. Sprint 1

The backoffice reactive application, which allows the app administrator to add new users, companies, and corporate groups, create various sorts of task types, and choose the location from which the weather API should obtain data, was the only focus of the first sprint. The major goal of the backoffice is to assist with application administration and the main configuration of the mobile app. Five users from the company in research, and five more users from other companies were added when the application had finished development. The sprint 0 database diagram above shows how the application was set up to work with many organizations from the same users, these configurations were done also in the backoffice.

4.1.3. Sprint 2

The initial "production deploy" and the first app functionality were created during this sprint. Given that this is research, the app was created in a free Outsystems account, which only has one development environment. Therefore, all the modules were duplicated, to emulate two different environments with the only difference being that "_dev" was added to the end of their names to distinguish them from the production environment.

No major challenges were found during these two weeks in which these next screens were developed:

- Homepage
- Employee
    - List

- Add/Edit
- Fields
  - List
  - Add/Edit

At the conclusion of the sprint, a demo was put together to show to the users the functions created, and they weren't thrilled with the homepage's appearance, complaining that it was unattractive and information that was displayed was of little value to them. Therefore, in one of the following sprints, it became a priority to implement something on the homepage that would benefit the business.

4.1.4. Sprint 3

Two new screens must be created to improve one of the application's key features, task tracking. The screen for products and plants has two tabs as we can see in the Figure 4 bellow; one of them lets the user add products to use for chores, while the other lets them add crop varieties to use when planting. The plants and items introduced to this screen in the future will also be available on the checkout page. Plus, a screen to add pest to also use on the task's creation. Additionally developed for this reason was a disease screen. users to understand which substances treat what.

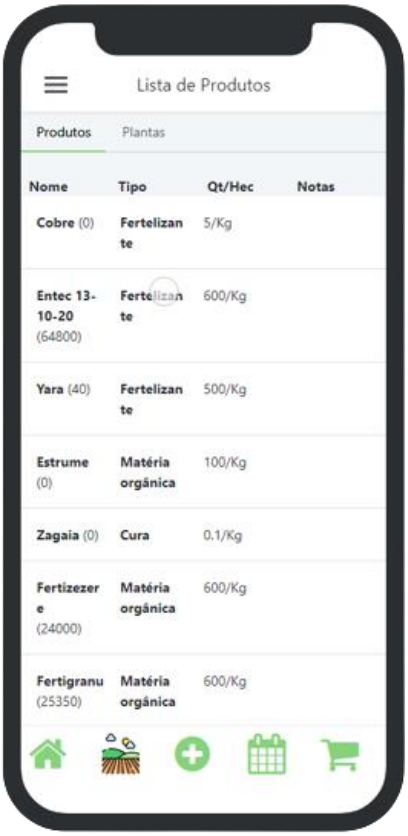

Figure 4- Product List

Figure 3 - Homepage

With a couple of days left to the end of the sprint it was time to improve the homepage. It was simple to identify that the weather prediction was a feature that was lacking after collecting data from brief interactions with people. Considering this, I investigated weather forecasting APIs and discovered Open Weather Map right away. Although the free version had certain restrictions, it was otherwise entirely functional. One of these drawbacks is that the free edition only offers the daily forecast, which is separated into seven periods for example for the 21/07/08 the API returns the for cast for: 00:00;03:00;06:00;09:00;12:00;15:00;18:00. This information is being retrieved from the API daily with an Outsytems timer (IMAGES X) that runs at 23.30 to not excess the number of requests for the free account the weather location previously added in the backoffice were used to only retrieve necessary information.

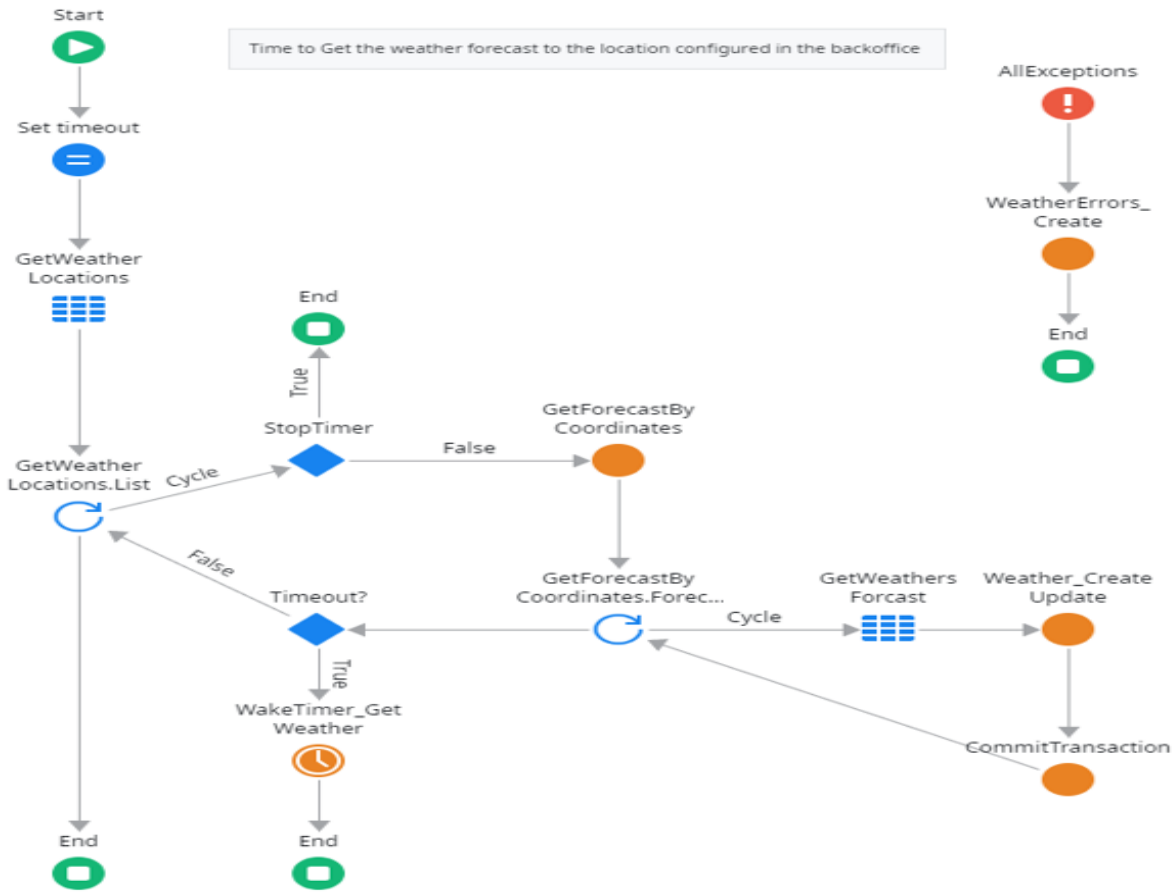

Figure 5 - Timer Sync Weather

At the conclusion of the sprint, users were shown all the functions created and instructed on how to begin using the new interface. They were really pleased with the advancements achieved and the redesigned site seen in Figure 3.

4.1.5. Sprint 4

It was time to start creating the primary functionality because the start of the agricultural season was just a month away sprint 4 was used for this. Before reaching the current version, the screen on Figure 6 undergone several revisions. Due to the platform's free version only storing versions from the last thirty days, images from the remaining versions could not be obtained.

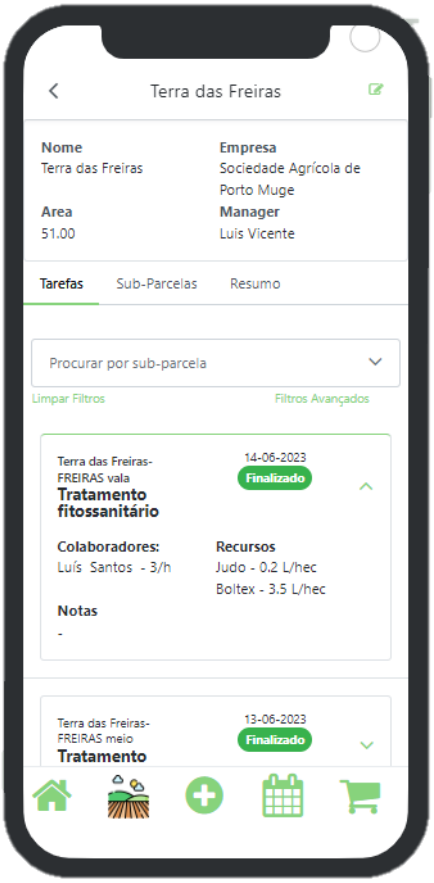

Figure 6 - Field Detail/ Taks Detail page

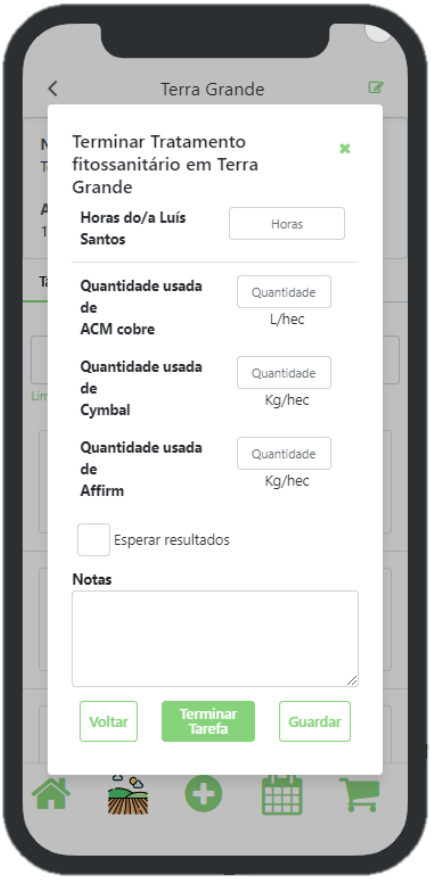

Figure 7 -Finishing Task Details

This screen is assessable from the field list by clicking in one of the fields and is composed of three many parts, one of which being the visualization of the field information and the editing of the same by clicking on the icon on the top left will open a popup window with the editable information of the field. Two tabs were constructed on the bottom half of the page, with the content of each tab created using webblock to improve code readability. One webblock included task data for that field with the option to filter by sub-field, range of dates each card on the task list each card has all the information about that task such as how time much the employee spent on the task, products that were used and quantity spend, that information can be added by swiping left on each card when the task is in progress Figure 7. The sub-fields are listed on the tab called "Sub-Parcelas" and the user can use the bottom bar menu plus icon to open the current tab form and add a task or subfield, on the sub-field tab will open popup with a small form and for the task tab will redirect to the task creation page.

Following a debate about what should be improved after demonstrating the functionality to users and seeing their difficulties using the program, we came up with the following list:

1. Opening the task creation page by clinking on each sub-field.
2. Swiping left to edit each sub-field.
3. Swiping right to delete (This was done in every list in the application).
4. Make the icon that are clickable bigger.
5. Add a button to export all the tasks made in the fields to an excel sheet.

These improvements were made in the following sprints.

4.1.6. Sprint 5

The sprint began by making the improvements requested by users in the previous sprint. For the new functionality requested, export to excel, a new page was created in the menu called "Gerar Ficheiros", this page allows the user to search by field and/or product and/or task and export the result to excel for the purpose of sending for agronomists to check what was done in the fields.

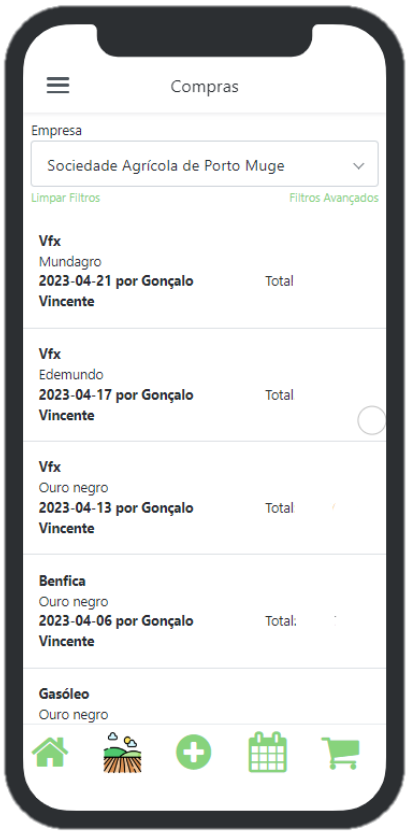

Figure 8 - Purchase List

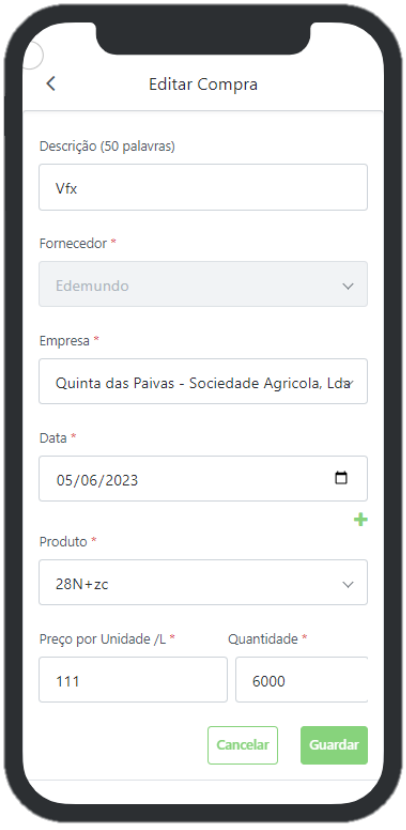

Figure 9 - Purchase Detail

After these improvements, the rest of the time was dedicated to the functionality of recording purchases and company expenses on products and land rent. The images above illustrate the list of purchases and the form to add and edit purchases. (Figure 8,Figure 9)

4.1.7. Sprint 6

The goal of this sprint was to monitor the application in case a bug appeared in production. This sprint's only bug, which was quickly found, fixed, and deployed to production, was on the purchases list that failed to display the company that made the purchase. The bug was in the insert statement on the purchase form because the CompanyId and CompanyGrougId were not yet assigned. Due to the necessity of copying code between modules to emulate the two environments, many errors surfaced during the sprints. Occasionally, the code was forgotten in the development environment, and the bug was discovered during some tests conducted in PRD on an account for this reason.

A time sheet for the company's employees to aid with management, which was presently done through a paper handed to employees every week to calculate your wage, was a feature recommended by users in the meeting at the end of the last sprint. With the few flaws found, I chose to continue forward with this feature shown in the next Figure 10.

Figure 10 - Timesheet page

It was proven that users of the program weren't using it after a few months of this capability being in use. After speaking with a few of them, it became clear that the primary cause of this was the necessity of roughly forty employees manually entering this data each week. I made the decision to attempt to improve the functionality in the upcoming update of the app so that it is easier to use.

4.2. NEW USERS

Started trying to get a few additional users to test the application in sprint 6. I got to speak with three more customers who between them ran more than five hundred hectares of agricultural land and had four distinct firms, all of which were in the same industry as the company under study. I also believed it was a good idea to seek the advice of an agronomic, and I was able to include two in my application who provided me with helpful guidance on my next step of app.

4.3. GATHERING RESULTS

The development phase has been completed, and a few months to pass so that users may use the application and form opinions about it. I attempted talking to the app users to set up a meeting to acquire their perspectives to schedule the focus groups outlined in the methodology. I was aware that it would be challenging to gather all the users for a meeting in July, during the peak of the tomato harvest. Thus, we decided to discuss the application over dinner and make some observations about the application usability and functionalities that would be included in the following chapter. The other user group, which would discuss best practices and the architecture of the solution used by Outsystems, might more readily be organized through online conference with current and previous coworkers.

5. RESULTS AND DISCUSSION

The usability and influence of the application on agricultural processes were the main topics of one focus group, while a code review and best practices evaluation were the main topics of the other. The results and findings from these two separated but connected focus groups are presented and discussed in this part. These results give a comprehensive picture of the performance, user experience, and development quality of the OutSystems application in the context of the agricultural industry.

5.1. USER FEEDBACK ANALYSIS

5.1.1. User Experience and User Interface (UI/UX)

The initial focus group's user input showed that they had a generally favorable opinion of the OutSystems application's user interface (UI) and user experience (UX). Participants praised the software for its clarity and usability, highlighting the uncomplicated design that enhanced the user experience. Participants did, however, also provide helpful ideas for enhancement, particularly regarding boosting the application's appearance while preserving its usability. This positive reception of the design lays a strong foundation for its continued success in the agricultural domain.

5.1.2. Business Workflow Impact

Findings of the first focus group highlight the application's strong influence on agricultural processes. Users noted that the tool expedited data collecting procedures, particularly during essential operations like planting and crop management. This productivity gain and measurable time savings demonstrate the application's actual value in streamlining agricultural business procedures. Real-time data availability also proved to be a useful tool for decision-making. Participants acknowledged that having access to current data would be crucial for making educated decisions, which would eventually lead to more effective and sustainable farming methods.

5.1.3. Benefits and Challenges

The first focus group identified several benefits associated with the use of the OutSystems application:

Remote Data Availability: The application's ability to provide data access in remote agricultural locations where traditional data storage methods were impractical was a key advantage.

Reduced Paperwork: Users appreciated the reduction in paperwork and manual data entry, which not only saved time but also resulted in cost savings.

Flexibility and Scalability: The application's fast adaptability to various farming tasks and its scalability were seen as advantageous in addressing the diverse needs of the agriculture sector.

Although the advantages were clear, participants also pointed out certain difficulties:

Privacy and Data Security: Concerns about data privacy and security arose, particularly when sensitive agricultural information was exchanged through the application.

Training Requirements: Several participants noted the need for more comprehensive training to harness the full range of the application's functionalities.

Connectivity Issues: Connectivity problems in outlying rural areas were brought up, indicating that network reliability remains a challenge in some agricultural contexts.

5.2. Code analysis and Best practices assessment

5.2.1. Code Review

The code review and best practices assessment from the second focus group yielded valuable insights into the application's development quality:

Positive Aspects

Adherence to Naming Conventions: It shows strong development discipline that the codebase constantly adhered to OutSystems' naming and coding guidelines.

Patterns and Reusable Components: Participants praised the constant application of patterns and reusable parts, which improved the maintainability and uniformity of the code.

Areas to Improve

Repetitive Code Blocks: Some areas of the code exhibited repetitive code blocks, suggesting opportunities for refactoring and code optimization.

Indentation Issues: Incorrect indentation in certain code sections was identified as a minor flaw that could be addressed for better readability.

Offline Capability: All focus group members felt that adding offline functionality to the application was a smart idea given the nature of the business under consideration.

5.2.2. Best Practices Assessment

The codebase demonstrated almost complete compliance with OutSystems best practices, including the separation of concerns and modular design. However, participants noted potential areas for improvement in code optimization, particularly in frequently accessed modules.

5.3. Discussion

The combined findings from the two focus groups provide a thorough picture of the effectiveness of the OutSystems application and its potential for improvement in the agricultural industry.

Usability and Impact on Agricultural Workflows: The application's improved business workflows and satisfied users are in line with the goals of agricultural apps. Improving farming efficiency and decision-making requires streamlining data collecting, cutting paperwork, and offering real-time data access.

Development Quality and Best Practices: The program mostly followed coding standards and best practices, according to the code review and best practices evaluation. However, there is still opportunity for improvement and code reorganization, especially in performance-related modules. Separation of concerns and adherence to modular design principles are positive signs for the application's maintainability.

Challenges and Suggestions: Concerns about privacy and data security, the necessity for training, and periodic connectivity problems all emerged as difficulties. To guarantee the application's continuous success in various agricultural contexts, these difficulties must be overcome. The recommendations, performance optimization, offline functionality, and documentation are in accordance with industry standards for application development.

In conclusion, this study offers a thorough knowledge of the function of the OutSystems application in the agriculture industry. Although the program has demonstrated its worth in improving agricultural processes, the problems found, and user ideas are helpful for further development and improvement. The application can further contribute to higher productivity and sustainability in the agriculture sector by tackling these issues and seizing the potential for future development.

6. CONCLUSIONS AND FUTURE WORKS

The OutSystems application will be developed and evolved in a way that takes these future directions into account. This will not only help to solve current problems, but also guarantee that the application will continue to be a useful asset for the agriculture industry, promoting efficiency and sustainability.

While some of the initial objectives were met with success and others were not, the firm has greatly benefited this year from the concentration of information to aid in decision-making. In my opinion, the upcoming year will have even more significance, since a more comprehensive database will aid in decision-making even more. However, the employee management module was not utilized very often. I believe this is because, although it appears in the program, the firm administrators are required to complete the time sheets using this module, rather than the employees themselves on paper.

This employee's modules is definitely on to improve and based on the last topic the combined findings from both focus groups offer several avenues for future research and development:

1. **Privacy and Security Enhancement:** To address user concerns and assure compliance with data protection laws, data security features and privacy controls should be strengthened;
2. **Enhanced Training:** Create extensive training programs, including user manuals, tutorials, and online resources, to empower users and assist them in maximizing the capabilities of the application;
3. **Offline Capabilities:** Implement offline capabilities to ensure smooth operation in places with poor connection, reducing the effects of patchy network availability;
4. **Performance optimization:** Perform a thorough examination of the system's performance, spot any bottlenecks, and put improvements into place to improve the responsiveness and scalability of the system;
5. **Logging and Monitoring:** Enhance the application's logging and monitoring capabilities for real-time issue detection and proactive maintenance;
6. **Documentation:** To make future development and onboarding processes easier, create thorough documentation that captures important architectural decisions and design patterns;
7. **Regular User Feedback:** Continue conducting focus group sessions with a diverse set of users to gather ongoing feedback and ensure that the application evolves to meet changing agricultural needs;
8. **Integration and Expansion:** Investigate possibilities for combining the application with other agricultural technology and extending its capabilities to include other farming-related activities, such harvesting and pest control.

BIBLIOGRAPHICAL REFERENCES

Adnan, N., Nordin, S. M., Rahman, I., & Noor, A. (2018). The effects of knowledge transfer on farmers decision making toward sustainable agriculture practices: In view of green fertilizer technology. *World Journal of Science, Technology and Sustainable Development*, *15*(1), 98–115. https://doi.org/10.1108/WJSTSD-11-2016-0062

Baxter, P., & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *Qualitative Report*, *13*. https://doi.org/10.46743/2160-3715/2008.1573

Bersani, C., Ouammi, A., Sacile, R., & Zero, E. (2020). Model Predictive Control of Smart Greenhouses as the Path towards Near Zero Energy Consumption. *Energies*, *13*(14), Article 14. https://doi.org/10.3390/en13143647

Bock, A. C., & Frank, U. (2021). Low-Code Platform. *Business & Information Systems Engineering*, *63*(6), 733–740. https://doi.org/10.1007/s12599-021-00726-8

Brown, J. S. (2003). Letters from John Seely Brown and John Hagel III. *Harvard Business Review*, 1–17.

Charatsari, C., D. Lioutas, E., De Rosa, M., & Papadaki-Klavdianou, A. (2020). Extension and Advisory Organizations on the Road to the Digitalization of Animal Farming: An Organizational Learning Perspective. *Animals*, *10*(11), Article 11. https://doi.org/10.3390/ani10112056

Conboy, K., Fitzgerald, G., & Mathiassen, L. (2012). Qualitative Methods Research in Information Systems: Motivations, Themes and Contributions. *European Journal of Information Systems*, *21*. https://doi.org/10.1057/ejis.2011.57

da Silveira, F., Lermen, F. H., & Amaral, F. G. (2021). An overview of agriculture 4.0 development: Systematic review of descriptions, technologies, barriers, advantages, and disadvantages. *Computers and Electronics in Agriculture*, *189*, 106405. https://doi.org/10.1016/j.compag.2021.106405

Deichmann, U., Goyal, A., & Mishra, D. (2016). Will digital technologies transform agriculture in developing countries? *Agricultural Economics*, *47*(S1), 21–33. https://doi.org/10.1111/agec.12300

Ebert, C., & Duarte, C. H. (2018). Digital Transformation. *IEEE Software*, *35*, 16–21. https://doi.org/10.1109/MS.2018.2801537

Fowler, M., & Highsmith, J. (2001). *Facilitating change is more effective than attempting to prevent it. Learn to trust in your ability to respond to unpredictable events; it's more important than trusting in your ability to plan for disaster.* 7.

Highsmith, J., Fowler, M., Beedle, M., Bennekum, A. van, Cockburn, A., & Cunningham, W. (2001, February). *Manifesto for Agile Software Development*. https://agilemanifesto.org/

Hrustek, L. (2020). Sustainability Driven by Agriculture through Digital Transformation. *Sustainability*, *12*(20), Article 20. https://doi.org/10.3390/su12208596

Huff, T. (2019, July 11). *Adapting Agile to Build Products with Low-Code: Tips and Tricks*. https://www.outsystems.com/blog/posts/adapting-agile-to-low-code/

INE. (2022). *Inquérito à utilização de tecnologias da informação e da comunicação nas empresas*. https://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=585250024&att_display=n&att_download=y

Kanji, G. K., & Wallace, W. (2000). Business excellence through customer satisfaction. *Total Quality Management*, *11*(7), 979–998. https://doi.org/10.1080/09544120050135515

Lammers, T., Tomidei, L., & Regattieri, A. (2018). What Causes Companies to Transform Digitally? An Overview of Drivers for Australian Key Industries. *2018 Portland International Conference on Management of Engineering and Technology (PICMET)*, 1–8. https://doi.org/10.23919/PICMET.2018.8481810

Marucci, A., Colantoni, A., Zambon, I., & Egidi, G. (2017). Precision Farming in Hilly Areas: The Use of Network RTK in GNSS Technology. *Agriculture*, *7*(7), Article 7. https://doi.org/10.3390/agriculture7070060

Mi-451-research-intelligent-process-automation-analyst-paper-f11434-201802.pdf. (n.d.). Retrieved December 3, 2022, from https://www.redhat.com/cms/managed-files/mi-451-research-intelligent-process-automation-analyst-paper-f11434-201802.pdf

Outsystems. (2021, March 9). *Develop secure OutSystems apps—OutSystems Support*. Develop Secure OutSystems Apps. https://success.outsystems.com/Support/Security/Develop_secure_OutSystems_apps#

Outsystems. (2022, April 15). *Infrastructure architecture and deployment options*. Infrastructure Architecture and Deployment Options. https://success.outsystems.com/Documentation/11/Setup_and_maintain_your_OutSystems_infrastructure/Setting_Up_OutSystems/Possible_setups_for_an_OutSystems_infrastructure/Infrastructure_architecture_and_deployment_options#

Pihir, I., Tomičić-Pupek, K., & Furjan, M. T. (2018). *Digital Transformation Insights and Trends*. 10.

Sanchis, R., & Poler, R. (2019). Enterprise Resilience Assessment—A Quantitative Approach. *Sustainability*, *11*(16), Article 16. https://doi.org/10.3390/su11164327

Schwertner, K. (2017). Digital transformation of business. *Trakia Journal of Science*, *15*(Suppl.1), 388–393. https://doi.org/10.15547/tjs.2017.s.01.065

Shinde, S., Kimbahune, S., Singh, D., Deshpande, V., Piplani, D., & Srinivasan, K. (2014). mKRISHI BAIF: Digital transformation in livestock services. *Proceedings of the India HCI 2014 Conference on Human Computer Interaction - IHCI '14*, 148–153. https://doi.org/10.1145/2676702.2677200

Tekinerdogan, B. (2018). *Strategies for Technological Innovation in Agriculture 4.0*.

The Forrester Wave™: Low-Code Development Platforms For Professional Developers, Q2 2023. (n.d.). Retrieved October 24, 2023, from https://reprints2.forrester.com/#/assets/2/160/RES178497/report

Van Rijswijk, W., & Frewer, L. J. (2012). Consumer needs and requirements for food and ingredient traceability information. *International Journal of Consumer Studies*, *36*(3), 282–290. https://doi.org/10.1111/j.1470-6431.2011.01001.x

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*, 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Vicent Paul, Iijima Kimihiko, Leow Adrian, West Mike, & Matvitskyy Oleksandr. (2022, December 31). *Magic Quadrant for Enterprise Low-Code Application Platforms*.

Wang, X., Conboy, K., & Cawley, O. (2012). "Leagile" software development: An experience report analysis of the application of lean approaches in agile software development. *Journal of Systems and Software*, *85*(6), 1287–1299. https://doi.org/10.1016/j.jss.2012.01.061

Waszkowski, R. (2019). Low-code platform for automating business processes in manufacturing. *IFAC-PapersOnLine*, *52*(10), 376–381. https://doi.org/10.1016/j.ifacol.2019.10.060

Yahya, N. (2018). Agricultural 4.0: Its Implementation Toward Future Sustainability. In N. Yahya (Ed.), *Green Urea: For Future Sustainability* (pp. 125–145). Springer. https://doi.org/10.1007/978-981-10-7578-0_5

Yin, R. K. (2003). *Case Study Research: Design and Methods*. SAGE.