Novel Regional Integrated ICT Platform For Agriculture Based On Open Standards

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Abstract: The agricultural industry is very important part of each economy, but agriculture also plays an important role in the effort to preserve the natural environment. Over the next decade, global demand for agricultural products is expected to increase, although it will grow at a slower rate. Increased productivity on less land with less water is becoming a priority. Agricultural productivity varies in different regions. Introduction of digital technology in agriculture is a precondition for increased productivity, but in order to facilitate further development, it is necessary to build an integrated agricultural platform. There were several efforts especially within the EU to create such a platform mainly based on open standards. The aim of this paper is to introduce an alternative reference model of regional agricultural platform (semi-open agricultural platform). Semi-open agricultural platform means that some of the software components should be delivered as commercial software from partner companies, while other platform components should be delivered as open source. Developing a basic architecture framework of Semi-open agricultural platform with associated business model of collaboration was the first objective of this paper. Second objective was related to platform promotion strategy and platform viability, sustainability and benefits.

Key Words: Integrated platform, Cloud, IoT, Agriculture, Partnerships

1. INTRODUCTION

The agricultural industry is very important part of each economy, but agriculture also plays an important role in the effort to preserve the natural environment. Over the next decade, global demand for agricultural products is expected to increase, although it will grow at a slower rate. Population growth is considered the first major driver of consumer growth (OECD / FAO, 2016). Increased productivity on less land with less water is becoming a priority. Agricultural productivity varies in different regions. North American countries produce 65 times more agricultural products per farmer than countries in sub-Saharan Africa (Ethiopia, Malawi, Madagascar, Zambia, Tanzania, Uganda, Ghana, Botswana and Nigeria) (World Bank, 2018). In the last 20 years, a number of scientists have conducted researches in an attempt to identify the reasons for the difference in agricultural productivity between countries around the world.

According to Fuentes JR and Mies V. (2012), adoption of technology is a key tool for improving agricultural productivity. Mahmud and Ahsan (2016) found that the use of new technology in Taiwan resulted in higher profitability of manufacturers due to the possibility of reducing the influence of intermediaries. The Halewood and Surya (2012) study shows that using technology has facilitated access to markets information, resulting in a 36 (thirty-six) percentage increase in agricultural income in countries such as Kenya, Ghana, Uganda and Morocco. The study by Teye et al (2012) emphasizes that the introduction of new technologies in agriculture is crucial for increased productivity, however, the adoption of technology is closely linked to local challenges. In Eastern and Southern Europe, the costs and demographic issues have been identified as key inhibitors for the introduction of new technologies, while in more advanced economies, where agriculture as industry is highly developed, standardization of new technologies and data integration were recognized as key inhibitors for further development.

According to research by Sørensen et al (2010), the lack of integration and standardization leads to inefficient business processes and reduces the possibility of rapid and simple integration of new technology and services. Nikkilä, Seilonen & Koskinen (2010) also recognized that data integration and standardization is of particular importance for the further development of agriculture as they encourage and enable the efficient exchange of information.

In order to better align the processes in the European agribusiness, the EU has funded a number of projects such as SmartAgriFood, ICTAGRI (www.ict-agri.eu), agriXchange (www.agriXchange.eu) and FutureFarm.

All these projects, each from their own aspect, gave a certain overview of the future agricultural platform. The success of the envisaged models were based on the future commitment of the consortium partners in the projects that generally came from the academic field in the form of research centers and faculties. However, it seems that EU most ambitious project in this domain was the promotion of the FIWARE platform. Namely in 2014, the EU and the consortium of multinational companies promoted the FIWARE, an open standards platform for developing projects in various verticals such as smart city projects, smart agriculture, etc. The initial budget for the project was around 80 (eighty) million euros. FIWARE project has been criticized from the outset as a waste of money. This was partly because FIWARE was built as bulky and inflexible platform with some design flaws and lack of updated documentation, but maybe even more important, because this project did not had a clear vision how to motivate software companies to start using the platform for developing purposes, nor did it define an appropriate way in which they can monetize (Salhofer, 2018).

In order to have a comprehensive overview about agricultural productivity, it is also necessary to make a summary of digital technologies (generic technological building blocks) used in agriculture. In accordance with the literature review, often mentioned technologies in agriculture are technologies based on sensor networks (Bastiaanssen et al., 2000), then Cloud Computing (Hashem et al., 2015) and Internet of Things (IoT) (Weber and Weber, 2010). All of these technologies are the foundation of so-called "smart agriculture" (Tyagi, 2016; Babinet Gilles et al., 2015).

In accordance with research made by Charvat K. (2012), the new future services in agriculture should be developed based on following technologies:

- Internet of Things (IoT);
- Cloud computing;
- Spatial Data and Geographic Information Systems;
- Development based on an open platform

Digital technologies in agriculture generate a large amount of data, leading to investment in infrastructure for data storage and processing (Nandyala and Kim, 2016; Hashem et al., 2015). Even though Big Data seem to become very popular and useful technology in different vertical markets, it started to be applied in agriculture as of late (Lokers et al., 2016), when stakeholders have started to see its prospective benefits (Bunge, 2014; Sonka, 2016).

From the foregoing it can be concluded that introduction of digital technology in agriculture is a precondition for increased productivity, but in order to facilitate further development, it is necessary to build an integrated agricultural platform. There were several efforts especially within the EU to create such a platform, but it appear that most of them are not being much used in Eastern and Southern Europe.

It seems that the creation of a regional integrated platform for agriculture focused on end users instead of developers is a more appropriate approach. In this article, an alternative reference model of such a platform (semi-open agricultural platform) will be introduced.

2. RESULT AND DISCUSSION

2.1. Basic requirements of Semi-open agricultural platform

Most of the EU funded projects related to development of integrated platform were leveraging the benefits from open source development such as lower initial cost, flexibility and openness. However, there are several disadvantages associated with open source development like long-term cost, lack of extensive technical support and security.

The idea behind the new proposed alternative reference model is to grasp the best of the two worlds (proprietary and open source platform). Semi-open agricultural platform means that some of the software components should be delivered as commercial software from partner companies (products like ERP application, mobile applications, etc.), while other platform components (core integration engine and platform adapters needed to connect the platform to OSS / BSS systems) should be delivered as open source.

The decision for open source license should be based on the following factors:

- Is it possible to make changes to a given component with another one without the source code rebuilding and deployment?
- Does changing a given components mean changing the functionality of the services (e.g. Cloud service, sensor service, application services) that users receive from the platform?

There are several types of architecture used in designing software applications. Among the most commonly used architectures are the Monolithic

Type of Software Solution, the Microservices and SOA (Service Oriented Architecture).

Each of these approaches has its advantages and disadvantages, and the elected approach depends on what needs to be obtained as a result. Microservices are better suited for smaller and better-partitioned WEB based systems in which micro services provide the developer a greater control over the application. Service Oriented Architecture is better adapted for large and complex environments of business applications that require integration of many heterogeneous applications.

Bearing in mind that the proposed semi open designed of agricultural platform is based on set of commercial services and open API interfaces, the most appropriate approach is the use of Service Oriented Architecture, because this architecture allows different heterogeneous applications to work together through different languages and platforms. The Service Oriented Architecture is based on the principle of loose-coupled applications interconnected through the API interface in order to simplify the implementation and maintenance of the platform. Loose-coupled elements will reduce the platform provider dependences from individual components (modules) that are part of the overall design of the platform. As the name implies, services are the basic building blocks in Service Oriented Architecture and they can be combined in order to create composite services.

The first step in creating a semi-open agricultural platform is based on defining a package of non-functional and functional requirements.

Non-Functional Requirements

Non-functional requirements include various aspects of agricultural platform such as: Scalability, Performance, Compatibility and portability, Configuration and modularity, Internationalization, Flexibility, Integration, Security, Open standard and Databases. The brief overview of the non-functional requirements of the agricultural platform is given below:

- Scalability: Ability for horizontal scaling (adding new servers for handling of increasing number of users). In order to meet this criterion, the platform from a technical point of view should be based on Cloud technology.

  In terms of infrastructure, Cloud infrastructure owned by the vendor or Cloud infrastructure from one of the public Cloud providers such as Amazon (Amazon SNS -Simple Notification Services and Amazon AWS) or Microsoft (Azure Messaging Service and Azure platform) could be used;
- Performance: Response time of maximum 20 seconds when Internet speeds are less than 400 kb/s. The performance of the platform at low internet speeds is of particular importance given that the lack of broad band internet in rural areas is probably a challenge for all European countries;
- Compatibility and portability :
  - Mobile applications must be supported by smartphones with iOS and Android operating system;
  - The administrative portal should be supported by almost all major search engines such as Safari, Chrome and Microsoft Edge;
- Configuration and modularity:
  - The platform should have ability to switch on/off a particular module (application) For example 2 (two) modules could be available for one country, while 3 (three) modules could be available for another country;
  - Rebranding per country (logo, color, font) should be enabled;
- Internationalization (platform services for multiple countries) :
  - The platform should be able to take into account the specific requirements of users from different markets: style, idea, culture, etc.
  - The platform should support internationalization: languages, text direction, dates, etc.
- Flexibility: The architecture of the platform should support integration of multiple data sources that can be configured differently for different countries. This section is of particular importance for end users in the domain of information and notifications delivery;
- Integration: An API should be provided for third-party software companies that would like in the future to integrate their product into the agricultural platform;
- Security: The security should be ensured on several levels. The first level is the level of network security (ex. firewall, antimalware, antispam security etc.). The second level of

protection is based on creating backups that are stored in accordance with the provider's data storage policy or is based on specific application requirements. The connection between the server infrastructure and data storage devices should be encrypted with AES technology and AES and SSL security protocols. The data stored on the data storage devices should also be encrypted.

The third level is role/permission based security. System should also enforce password policy and/or complexity such as minimum length, numbers, and alphabet requirements and upper and lower case constraint. User authentication should be controlled only by user account and password in order to reduce the complexity (no certificates, biometric etc.)

- Open standard: With the exception of commercial applications, other segments of the agricultural platform should be based on one of the following open standards: EUPL (European Union Public License), GNU, General Public License, or Apache License.
- Database: There should be three types of database: Personal database, OLTP (Online Transaction Processing System) and OLAP (Online Analytical Processing System) database
  - The personal database is a separate database that stores the end users personal data. In accordance with local laws, this database may need to be stored in different location compared to OLTP and OLAP databases. MySQL can be used for storing end users personal data.
  - The main function of OLTP is to store, update, change and delete transaction data. The OLTP database is updated frequently, with each transaction from sensor equipment or from ERP. The OLTP system is a major source of data for the OLAP database. Communication between OLTP and OLAP databases is via the ETL tool (extract, transform, load). ETL combines three database functions into one tool to pull data out of one database and place it into another database. As OLTP database, PostgreSQL or MS SQL can be used.
  - OLAP is an online analytical data processing system. Based on predefined tools in the OLAP database, complex analyzes can be performed that will enable the user to get a more dimensional view of the data. OLAP enables a process of generating a needed information on demand from a large database to facilitate the analysis and decision making process. MS Analysis Service can be used in this domain.

Functional Requirements

Functional requirements include features that are closely linked with the business value of the platform itself. There are functional requirements that are generic and service-independent and functional requirements that are closely related with the services that will be provided by the agricultural platform.

In the first group we may include:

- Admin portal: Admin portal should have several functionalities like User management, News moderation and editing, Knowledge base management, Taxonomy management and ability to add new content providers (RSS);
- Users profiles: Platform should enable different users profile such as:
  - Admin: The responsible person is a vendor’s employee. This is a super user who administrates the system and its users and provides the supervision on its functionality;
  - Content manager: The responsible person is a vendor’s employee who uses the system for moderating the news and managing content in knowledge base;
  - Farmer: A person who has family/small farm and uses the system to learn about agricultural business, receive news and updates in agriculture;
  - Guest user: A user that uses the system for basic functionality and other free features without registration in the system;
  - Acceleration partner (optional): A person who is hired or contracted by the vendor for engaging farmers;
  - Consultant / Expert: A person who is hired or contracted by the vendor for providing consulting services to farmers.
- Identification and registration flow. For authentication purposes, platform should expose exactly the same API as the current vendor IDM (ID Management). Admin Portal will allow managing user roles and permissions. There should be ability to use application as Guest. Limited set of features

will be available for guest. User should be prompted to register in order to use features requiring authentication.

In the group of functional requirements that are closely related with the services that will be provided by the agricultural platform we may include :

- Agricultural ERP system enhanced with decision support system based on Big Data analysis;
- IoT services;
- GIS;
- Marketplace;
- Consulting services;
- Knowledge base;
- Information's;
- Notifications;
- Internationalization;
- WEB and Mobile Application.

These features will be further detailed in the text, within the description of the Service Oriented Architecture.

2.2. Service Oriented Architecture of the agricultural platform

Draft version of agricultural platform Service Oriented Architecture consist of 5 (five) levels namely Object oriented level, Component level, Service level, Process and Presentation level. All levels of the digital platform are interlinked with different types of services like API, REST, TCP / IP and HTTPS .

- API represent a set of functions and procedures that allow one application to access certain functionality of another application;
- REST is a web-based API that uses URL and HTTP protocol. The reason for using the REST API is because of its simplicity, lower security requirements and compatibility with WEB search engines;
- TCP / IP is a set of standardized rules that allow computers to communicate on a computer network such as the Internet;
- HTTPS is an extension of HTTP that provides encrypted communication protocol.

Level 1 - Object-based level

The first level is an object-based level, where all commercial applications are located. Other user applications that would be developed as an open source applications and databases that contain business functionality are also deployed on this level. In accordance with Service Oriented Architecture, the design of the object-based level is modular and the communication between the modules would take place in accordance with the pre-defined protocols. This approach will enable easier and faster integration of different commercial applications, but will also eliminate the dependence that would eventually arise from commercial software venders that were initially selected. All "objects" at this level can be used to build complex services. This level should make all functionalities available for other levels. API calls should also be used for communication purposes with the Admin API Gateway and respective clients on the next level (components level)

Several different modules such as My Farm Module, Knowledge Base Module, Finance Module, Information Module as well as Marketplace Module should be integral part of this level. With the exception of My Farm module, all other elements should be open based.

- My Farm should include an agricultural ERP enhanced with decision support system and IoT sensor integration platform.

  Agricultural ERP systems should include all modules that are present in small and medium-sized enterprise ERP systems (cash, orders for sales and purchases, e-business and online stores, invoicing, inventory management and storage, human resources, salaries, customs, fixed assets, services and other), but should also include different modules for different lines of agricultural activity such as module for bees, goats / sheep, poultry, pigs, horses, cattle , then module for cereals, nutrition, vegetable and forest. Agricultural ERP should contain tools for business intelligence (Big Data analytics). By using the parameters and information that come from different sources, these tools should be able to provide recommendations for improving the agricultural process.

  The IoT Sensor Integration Platform should be responsible for collecting and editing IoT sensor data. The platform should contain various software libraries (SDKs) that will enable integration of any device over the Internet. Additionally, the platform should be capable to do a management of any certified sensor equipment. Management includes provision of sensor information, connection monitoring, configuration management, sensor software management, office statistics charts, sensor restart commands, etc.

- A knowledge-based module should contain information on the best practices for growing different crops, based on which the farmer can make quality and timely decisions. Content manager within the admin portal should create the content manually. This section would also contain a segment on frequently asked questions as well as a segment of consulting services through which farmers could connect directly with consultants. Integration of Moodle platform might be the one of the most appropriate solutions here;
- Finance module need to be connected to external sources in order to be able to provide information related to exchange rates, loans and insurance terms and conditions. This module should provide online payments;
- Information module needs to be connected to an external provider of content. Within this module, the latest information about agriculture should be obtained (ex. prices of agricultural products on local markets). This module should include the ability to receive information from multiple different sources. The information should be approved and rebranded by the content manager within the Admin portal. Each rebranded content should be accompanied with information about the data source;
- Marketplace module should be proprietary software that offers the possibility of buying and selling.

Level 2 - Component level

Second level is the level of components where the elements that are responsible for the realization of the functionality of the services are located.

Level 3 - Services level

The intermediate level is the level of services, where all services that perform business functions, are located. The level of services connects the lower layers (object-based level and component level) with higher-level levels (process level and presentation level). This level should include the following individual services:

- Agricultural ERP;
- Various sensor equipment services such as weather station, pest monitoring system, livestock farming sensor network etc;
- Markeplace services;
- Separate services per state for Prices, Marketplace and Information
- Push server service intended for sending notifications and recommendations based on weather changes;
- Digital engagement platform services. This platform enables optimization of every contact that users make with the company, starting from the pre-sale process, sales to customer care, in order to increase the level of customer satisfaction;
- Consulting services. The farmer can submit questions with photo, description and select category of request from predefined list. Experts in each category will have access to the questions in their category. Expert will receive mail notification for each new question in the respective category. Each expert may have access to multiple categories assigned by admin. Expert can view the list of questions (statuses: open/closed) and provide answer via Admin portal. Farmer should receive notification about each answer from expert and he may close the request and rate the expert (stars from 1 to 5). Admin will be able to view basic report per Expert (statistics of asked/answered questions, rating) via Admin Portal.

The list of these services should be identical to the list of functional requirements associated with the services that a previously reviewed.

Level 4 - Process level

The next level is the level of processes. At this level, through service orchestration, services should be combined in order to create a single application. With a combination of services a composite services are created. Composite services bring additional benefits to farmers such as:

- Composite service that include Pest monitoring system, weather forecasts and agricultural ERP should provide information that will allow farmers to spray when and where is needed. On the other hand farmers wants to limit spraying as much as possible because of costs and consumer awareness of healthy food;
- With the integration of agricultural ERP with precision livestock farming sensor network,

the farmer can allocate costs and revenues down to specific animal.

Level 5 - Presentation level

The highest level is the presentation level and this is the agricultural platform access point for end user. This level should allow creation or translation of user requests and display of the received information. An access point can be a WEB application or a mobile application available for Android and iOS. Proposed technical stack that can be used for User interface is: JS, HTML5, Angular2, TwitterBootstrap and Node.js.

2.3. Platform business model

The concept of Semi-open agricultural platform is based on partnerships as an alternative model for developing new competences in comparison with internal growth or merger and acquisitions processes. In order to reduce the time to market and to create a win-win partnership, the provider of agricultural platform should define a procedure for selecting and engaging two type of partners:

- Partners with specific solutions that are technically capable to be integrated within the semi-open based agricultural platform;
- Indirect sales partners.

Based on best practice, several type of partnership models can be used for partner's engagement. These partnership models can vary from Basic or Advanced partnership model for partners involved in development of a new solution or Platinum, Gold, Silver partnership model for Indirect sales partners. Having said that, these partnership models should include different benefits and different revenue quota on annual level.

The cost structure for creating a semi-open agricultural platform should be based on a capital or investment (CapEx) type of cost. The cost structure associated with partnerships should be based on a variable type of operating (OpEx) cost. For different types of partnerships, different types of business model needs to be developed. For partnerships related to the creation of new services, the revenue sharing model should be applicable. For indirect sales, it is recommended to use a sales commission.

2.4. Payment and Service activation procedure

The majority of applications, at least initially, should be partner applications. Therefore, user registration, activation and service collection information must be registered not only in the agricultural platform provider OSS and BSS system but also in the partner OSS and BSS system. Agricultural platform services should be available through WEB application for fixed users and mobile application for mobile users. The WEB application is a user portal for purchasing, using, managing and canceling services. Mobile application should be free of charge. This means that downloading the app from GooglePlay or the Apple Store should be free of charge, and the login user should use the same credential as for the WEB application.

End user identification is the first step in buying services. This process should be completed thru provider web portal. After the user registration, process for buying or canceling the services should be done electronically via WEB portal through the payment and services activation/deactivation processes. In the following part of this paper, we will look at both of these processes separately:

- Payment process (illustrated in Figure 1 - marked in green color).

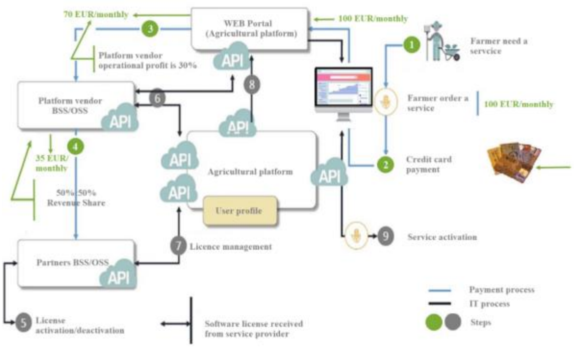
  The WEB portal should have a catalog of services where the user can choose services of interest. Within the catalog of services, in addition to the description of the services, there should be also information about the price of the service and the method of payment. By selecting the service of interest, the user selects a functionality that he wants to use. After accepting the terms of use of the service and after the credit card payment, the WEB portal through the platform adapters sends information to platform provider BSS system and at the same time sends information to the partner company BSS system. The information should include data about who is the user, what kind of licenses are ordered, for what period of time and the payment method. The information sent to the provider BSS and partner BSS will differ in the monetary amount given that the partner company should have information about its own part of the revenue share.

  The proposed revenue-sharing model between the platform provider and the service vendor is 50 (fifty) percent : 50 (fifty) percent from the profit. Namely, if the retail price of the service that the customer bought is 100 (one hundred) euros per month and if the cost of creating and maintaining the platform is 30 (thirty) percent of the price of any service, then the provider of the agricultural platform and the service vendor share 35 (thirty-five) euros each. The 100 (one hundred) euros revenue together with the accompanying information about the user and the service is recorded as information in the platform provider BSS system, while in the vendor BSS system, the information about 35 (thirty-five) euros revenue is recorded together with the same accompanying information about the user and the service.

- Service activation process (illustrated in Figure 1 - marked in grey color)

  After completing the service purchasing process, the service activation process begins. The partner company activates licenses in its BSS system and sends information about the activated license to the provider's agricultural platform through the API. On the other hand, the provider BSS system sends information to the agricultural platform about the retail price of the service. The agricultural platform transmits this two pieces of information via the API call to the WEB portal, which further down transmits this information to the end user.

Figure 1. A simplified model of the activation and payment process



The service cancellation and payment termination process is identical to the service purchasing/ activation process defined above. The difference is only in the initial part. User instead of accessing the catalog section of all available services, he accesses the section where he has insight into the company active services. In addition to each service from the list of active services, there should be a "deactivate" button, which initiate the process for service deactivation and payment termination.

2.5. Promotion of the agricultural platform

Promotion of the semi-open agricultural platform and related services should be conducted in two phases. The first phase of service promotion should take place during the agricultural platform development period and integration of the first partner applications. The promotion should take place into two directions. The first direction is aimed at investing in "pilot projects" with prominent agricultural enterprises, and the second is aimed at hiring consultants who would organize workshops for the end users of the pilot projects.

The goal of these workshops is to provide farmers with better understanding how to use the software and other equipment available for the pilot project. As part of the pilot project, each selected agricultural farm should receive a package of services enriched with IoT sensor equipment, free of charge in 6 months period. The selection of farms should be random, but in close cooperation with some farmers association, due to greater popularization and support of the promotion process. Farmer association employees could be used as consultants. Although consultants should have basic technical knowledge, they should initially need to attend to appropriate training organized by partners who have developed the appropriate services. Transfer of knowledge should be completed with the process of consultant certification. Upon completion of this process, consultants should be able to perform functional counseling services during the pilot projects. Functional counseling means at least the following: motivating why to use a certain functionality, explaining the benefits of that functionality, assisting in the interpretation and understanding of various data arising from the services and holding regular meetings and discussions. Through this working principle, feedback from the pilot projects should be provided. These feedbacks should be used in the process of development and upgrading of an agricultural platform.

The second phase of the promotion should start after the completion of the pilot projects. This is a phase in which marketing activities should help in promotion and sale of services.

2.6. Platform viability and sustainability

The proposed concept of an agricultural platform has regional/EU and national wide character. From a technical point of view, this platform is an open standard platform that empowers every ICT or consulting company to offer their products/services on the platform. On other hand due to services localization and adaptation to local legislation, the platform has a national character (platform will be intended for users in a particular country).

As previously described, some software components of the platform and the core integration engine will be open source, but the rest of the platform including all the products will be proprietary. Reputable regional companies that have a solid base of satisfied customers should be elected as partner companies that are going to deliver the commercial applications. Not only will these companies help in building the platform, but they it will also help in platform promotion and monetization. Partner companies will have a dedicated support team and should allocate a development team for future development of the platform.

2.7. Platform benefits

Introducing a semi-open agricultural platform is an alternative method of implementing a regional integrated agricultural platform. This approach differs from the cumbersome EU projects that are generally entirely based on an open platform. EU projects are focused on building a platform for development companies, while in this use case scenario, semi-open agricultural platform is focusing on end users. The semi-open agricultural platform benefits can generally be expressed within the following 6 (six) areas:

- The ability to automatically collect data directly from the field (sensor network) should improve the fields monitoring and can provide new capabilities to predict and act;
- Decision support system could provide a recommendations for improving the agricultural process;
- The close contact with consultants and use of early warning systems can provide timely response to a large number of hazards;
- Marketplace services will give greater insight into the primary and final products prices. In addition, the Marketplace could provide Web Store integration that will enable the sale of products on the open market;
- Openness and standardization will enable rapid integration of new ICT elements (applications, services, monitoring systems) on the platform without a possibility for vendor locking;
- Partners that are going to provide the proprietary software will ensure premium support and further service development.

Given that the introduction of the semi-open agricultural platform is a proposed concept that has not yet been implemented, a direct empirical measurement of the benefits of creating a semi-open agricultural platform is not feasible. However, based on macro-level surveys, 25 (twenty-five) percent and up to 35 (thirty-five) percent increase of productivity is expected, while the farm profit in the first years will remain the same due to the introduction of new costs for services. After the initial period of 2 (two) years, in addition to productivity gains, agricultural profitability is expected to rise.

3. CONCLUSION

The agricultural industry is vital part of each economy, but it also plays a crucial role in an attempt to protect the natural environment. Similar to GDP per capita, agricultural productivity varies in different regions. It is well documented that introduction of digital technology in agriculture is a precondition for increased productivity, but in order to facilitate further development, it is necessary to build an integrated agricultural platform. There were several efforts especially within the EU to create such a platform mainly based on open standards, but it appear that most of them are not being much used in Eastern and Southern Europe. In this article, an alternative reference model of regional agricultural platform (semi-open agricultural platform) is introduced in order to leverage the best of two words (proprietary and open source approach).

A semi-open platform means that part of the software components will be delivered as commercial software by partner companies, while the rest of the component will be delivered as open source software. The openness of the platform is intended to ensure the seamless integration of any new product or service, so that farmers will not be limited to the choice of one vendor equipment.

Bearing in mind that the proposed semi open designed of agricultural platform is based on set of commercial services and open API interfaces, the most appropriate approach is the use of Service Oriented Architecture, because this architecture allows different heterogeneous applications to work together through different languages and platforms. The draft version of Service Oriented Architecture contains 5 (five) levels namely Object oriented level, Component level, Service level, Process and Presentation level. All levels of the digital platform are interlinked with different types of services like API, REST, TCP/IP and HTTPS.

The first level is an object-based level. Several different modules such as My Farm Module, Knowledge Base Module, Finance Module, Information Module as well as Marketplace Module should be integral part of this level. With the exception of My Farm module, all other elements should be open based. The second level contain elements that are responsible for the realization of the functionality of the services. On the third level, all services are located. The fourth level is responsible for creation of composite services, while the fifth level or Presentation level is an agricultural platform access point for end user.

Creating a semi-open agricultural platform will enable the possibility of using advanced technology, which is a guarantee for increased efficiency in agriculture. Having in mind that semi-open agricultural platform is a proposed concept that has not yet been implemented a direct empirical measurement of the benefits of creating a semi-open agricultural platform is not feasible. In accordance with the literature review that covers the macro-level surveys in agriculture, it is expected and increased efficiency in a region of 25 (twenty-five) percent and up to 35 (thirty-five) percent.

REFERENCES

Babinet, Gilles et al., (2015): The New World economy, s.l.: Report addressed to Ms Segolene Royal, Minister of Environment, Sustainable Development and Energy, working group led by Corinne Lepage.

Bastiaanssen, W., Molden, D., Makin, I., (2000): Remote sensing for irrigated agriculture: examples from research and possible applications. Agric. Water Manage. 46 (2), 137–155.

Bunge, J. (2014): Big data comes to the farm, sowing mistrust: seed makers barrel into technology business, s.l.: Wall Street Journal (Online).

Charvat K. (2012): From external drivers to future challenges. ICT for agriculture, rural development and environment .Where we are? Where we will go? 51-58

Fuentes J.R. and Mies V.(2012): Productivity Differences in Developing and Developed Countries: Where are the Bottlenecks? Available on-line at https://www.isid.ac.in/~pu/conference/dec_12_conf/Papers/RodrigoFuentes.pdf. Access on 25.03.2018

Halewood, N.J; Surya, P. (2012): Mobilising the Agricultural Value Chain in 2012, Information and Communication for Development – Maximising Mobile, World Bank, Washington D.C.

Hashem, I., et al., (2015): The rise of “big data” on cloud computing: review and open research issues. Inform. Syst. 47, 98–115.

Information Systems in Precision Agriculture. In: Computers and Electronics in Agriculture 70 (2): 328-336.

Lokers, R., et al., (2016): Analysis of Big Data technologies for use in agro-environmental science. Environ. Model. Software 84, 494–504.

Mahmud S. and Ahsan K. (2016): Role of ICTs in Agriculture/Rural Development and Governance in Taiwan: A Report on Study Visit, Published by Bangla Desh Academy for Rural Development, Comilla, Bangla Desh.

Nikkilä, R, Seilonen, I & Koskinen K (2010): Software Architecture for Farm Management Nandyala, C.S., Kim, H.-K., (2016): Big and meta data management for U-agriculture mobile services. Int. J. Software Eng. Appl. (IJSEIA) 10 (1), 257–270.

OECD/FAO (2016): OECD-FAO Agricultural Outlook 2016-2025, OECD Publishing, Paris. http://dx.doi.org/10.1787/agr_outlook-2016-en. Access on 30.06.2019

Salhofer P. (2018): Evaluating the FIWARE Platform A Case-Study on Implementing Smart Application with FIWARE. Proceedings of the 51st Hawaii International Conference on System Sciences 2018. Страна 5797-5805

Sonka, S. (2016): Big data: fueling the next evolution of agricultural innovation. J. Innovation Manage. 4 (1), 114–136.

Sørensen, C. G., Fountas, S., Nash, E., Personen, L., Bochtis, D., Pedersen, S. M., ... Blackmore, S. B. (2010). Conceptual model of a future farm management information system. Computers and Electronics in Agriculture, 72(1), 37-47. https://doi.org/10.1016/j.compag.2010.02.003.

Teye, F., Holster, H., Pesonen, L., Horakova, S. (2012): Current Situation on Data Exchange in Agriculture in EU27 and Switzerland, ICT for Agriculture, Rural Development and Environment, T., Mildorf, C., Charvat, Jr. (Eds), Czech Centre for Science and Society Wirelessinfo, Prague, pp. 37-47.

Weber, R.H., Weber, R., (2010): Internet of Things. Springer, New York, NY

World Bank (2018): DataBankMicrodataData Catalog. Available on-line at https://data.worldbank.org/indicator/EA.PRD.AGRI.KD. Access on 25.03.2018