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A Farm Management Information System Using Future Internet Technologies

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Abstract: Agricultural production management is entering into a new era where every day farmer's decisions are supported by highly sophisticated Farm Management Information Systems (FMISs). The latter have evolved from simple record keeping software into complex systems that can manipulate large amounts of data and provide decision support capabilities. In this paper, the development of an FMIS, which utilizes new technologies, such as those which were introduced by the European initiative Future Internet Public-Private Partnership Program (FI-PPP), is described. The developed application is focused upon individual farmers or farmer cooperatives, who wish to perform precision agriculture via the usage of mobile devices and modern technology. The main focus is to perform farm financial analysis based on all farm transactions but also estimating profitability based upon fixed values that the farmer imports. The application was successfully tested on a winter wheat crop (*Triticum aestivum* L.) for one season, where all related costs were recorded.

Keywords: Big Data, Cloud Computing; Decision Support Systems; Internet of Things

1. INTRODUCTION

Farmers lack the tools to make informed decisions related to financial management of their business, taking into account cost and profit margins and profitability analysis. Farm Management Information Systems (FMISs), which are systems for storing and processing farm-related collected data, provide support to farmers for decision making in every-day farm management. Various types of system structures and software architectures have been proposed in the literature (Nikkilä, Seilonen, & Koskinen, 2010; Sørensen, Pesonen, Bochtis, Vougioukas, & Suomi, 2011; Tsiropoulos, Fountas, Gemtos, Gravalos, & Paraforos, 2013; Ampatzidis, Tan, Haley, & Whiting, 2016), while a number of commercial solutions are also available, such as Agworld[1], FarmWorks[2], and 365FarmNet[3], to name a few.

Nevertheless, farming is a complex endeavor and involves many factors and inputs: land cost, labor work, expensive machines and various tools, fertilizers, pesticides, irrigation, etc. For most farms, farm activities are not properly logged, at least not in a systematic and analytic way, while most data are fragmented, dispersed and difficult to use (Fountas, Carli, et al., 2015). Individual or family farm owners need Information and Communication Technology (ICT) tools that will enable them to log and calculate costs, plan future tasks and make informed decisions regarding what crop to plant, what farming activities to execute and what inputs to utilize based not only on crop and farming requirements but also based on financial (cost and revenue) considerations.

The European Commission launched in 2011 the Future Internet Public-Private Partnership Program (FI-PPP[4]), in order to provide innovative ICT tools. The overarching aim of the FI-PPP is to create a library of software components that are called *Generic Enablers* (GEs). The GEs should be public and open-source and allow developers to create mash-up applications by implementing innovative FI functionalities such as Cloud Computing, Internet of Thing (IoT) connectivity, and Big Data analytics. All GEs are developed and described in detail as a set of Application Programming Interfaces (APIs) in the FIWARE[5] platform. The FIWARE architectural chapters are provided in Fig. 1.

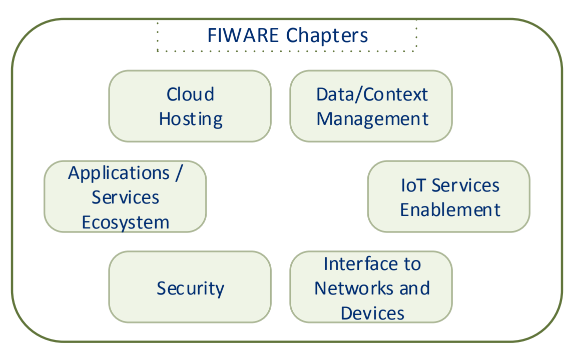

Fig. 1. Architectural chapters of the FIWARE platform.

[1] http://www.agworld.com.au
[2] http://www.farmworks.com/
[3] http://www.365farmnet.com
[4] http:// www.fi-ppp.eu
[5] http://www.fiware.org

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The usability of FI technologies in the context of environmental applications has been thoroughly examined by Granell et al. (2016) where it was discussed how FI is transforming the way that environmental software applications are being developed. New capabilities are introduced using the tools of FI towards analyzing geospatial and environmental data. Kaloxylos et al. (2012) described an FMIS functional architecture that utilizes advanced FI characteristics enabling the farmer to become "a node in an agricultural worldwide web". A detailed review regarding FI technologies and the agri-food sector was performed by Lehmann, Reiche, and Schiefer (2012) where the challenge of adopting advanced ICT components in agriculture is highlighted.

The aim of the paper is to describe the development of an FMIS for small and medium size farms that is able to use FI technologies. The use of these technologies would give the possibility to the application to incorporate new innovative technologies such as Big Data and IoT. Furthermore, the connection to 3rd party applications could be achieved in a standardized manner moving, thus, towards a software ecosystem where many FMISs are interconnected. The FMIS should also have a farm financial analysis tool, which is able to make a profitability analysis based on farmer's input data. Since in many occasions the farmer is not able to describe all farm-related costs, the profitability analysis should be able to provide a "good enough" approximation of the cost and an analysis using acceptable default values - typical costs per input and activity - in order to compensate for the lack of accurate data logs. These values can be found in official databases and usually they are based on accumulated research from a large number of farms at a national or an international level.

2. MATERIALS AND METHODS

2.1 The FMIS

A cloud based FMIS called *ifarma*[6] is developed by Agrostis Agricultural Information Systems (Thessaloniki, Greece). It is an integrated farm management application for individual farmers and farmer cooperatives, who wish to perform precision agriculture via the usage of mobile devices and modern technology. One main service of the ifarma is Farm Entities management. These entities and their hierarchical relations are depicted in Fig. 2. The software is able to handle multiple farms where all assets such as crops, fields, tasks, and inputs belong to.

The data model of ifarma integrates all information relevant to farm: fields and land parcels, crops, farming activities on fields and inputs and resources used to plan and execute theses activities. The data model organizes the information in a hierarchical manner, where farm is at the top level. A farm consists of a set of crops each one cultivated in one or more fields and executed as a series of tasks activities. Each one of the tasks consist of a set of inputs or resources. Inputs are prototypes, generic forms of resources that generalize characteristics of actual resources in categories such as labor, machinery, equipment, materials, etc. Farm specific resources are modeled as individual data entities such as workers, fertilizers, plant protection products, machines, etc. Both inputs and resources are assigned with their own unit cost and unit efficiency values per task. These values are used in order to calculate the total quantity and amount of this input/resource for each task.

MySQL was used as the database management system of ifarma imported data. The Entity Relationship model of the ifarma MySQL database is presented in Fig. 3. As an example all parameters of farms entity are illustrated. A separate set of data entities is used to represent financial

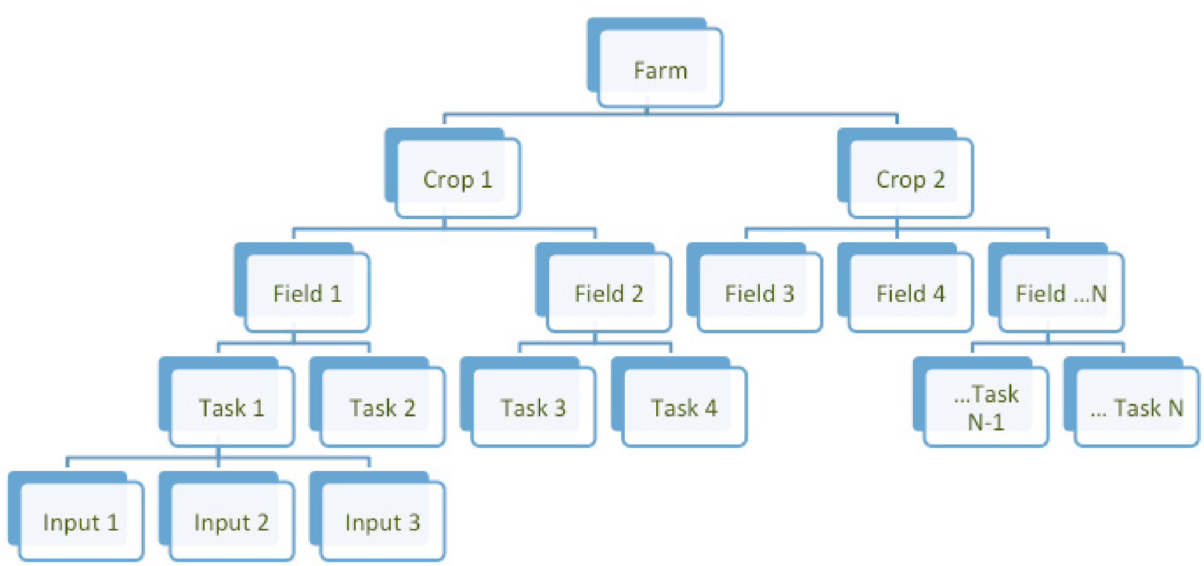

Fig. 2. Farm entities model of ifarma.

[6] http://ifarma.agrostis.gr