Data Entities and Information System Matrix for Integrated Agriculture Information System (IAIS)

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Abstract. Integrated Agriculture Information System is a system that is developed to process data, information, and knowledge in Agriculture sector. Integrated Agriculture Information System brings valuable information for farmers: (1) Fertilizer price; (2) Agriculture technique and practise; (3) Pest management; (4) Cultivation; (5) Irrigation; (6) Post harvest processing; (7) Innovation in agriculture processing. Integrated Agriculture Information System contains 9 subsystems. To bring an integrated information to the user and stakeholder, it needs an integrated database approach. Thus, researchers describes data entity and its matrix relate to subsystem in Integrated Agriculture Information System (IAIS). As a result, there are 47 data entities as entities in single and integrated database.

Keywords: Integrated Agriculture Information System, Data Entity, Information System Matrix

1. Introduction

Agriculture is one of the important sectors in Indonesia. Development of Technology in agriculture sector as a government research focus during 2015 – 2045 (Kementrian Riset, Teknologi, dan Pendidikan Tinggi, 2016). Information Technology as one of technologies that is able to support food self-sufficiency through improvement in quality and quantity of agriculture product. This technology is able to support improvement in economic added value for agriculture sector. Implementation of Information System in Agriculture has been implemented in Kenya (Rees, et. al., 2000), Croatia (Renko, Nikolasevic, and Pavicic, 2002), China (Wet, et. al., 2007). Farmers are also has been realized that the usage and importance of implementation Information Technology in Agriculture. 76.81% of farmers agree that Information and Communication Technology (ICT) should be optimized in Agriculture sector and they are ready to be trained the usage of ICT in Agriculture sector. This will be a good motivation to implement ICT in Agriculture Sector. Implementation of ICT for agriculture also has been supported by a good communication infrastructure in rural area, such as telephone network, ISP, and wireless connection.

Researchers are conducting study to build Integrated Agriculture Information System (IAIS). IAIS is a system that is developed to process data, information, and knowledge in Agriculture sector. This system has some subsystems which are connected and linked with integrated database. To build IAIS, researchers developed architecture using Enterprise Architecture Method. TOGAF Enterprise Architecture is chosen to build the blueprint and architecture. One elements of TOGAF Enterprise Architecture is Data Architecture. Data architecture is an approach which is needed to understand and address data management issues. TOGAF data architecture is an element that describe the structure of an organization's logical and physical data assets and management resources. A structured and comprehensive approach to data management enables the effective use of data to capitalize on its competitive advantage. This paper proposes the development of data architecture for integrated

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agriculture information system. This architecture is based on TOGAF framework which implements holistic approach starting from its organization, its function, its service, and its goal.

2. Literature Review

2.1. e-Agriculture

Development of Information and Communication Technology is perceived not only by urban community but also rural community. In rural area, development of Information and Communication Technology can be related with area economic development. Furthermore, open access to Information and Communication Technology will be opened rural area to market access. Development of Information and Communication Technology in rural area is able to help local business to be more competitive by increasing production capacity. Thus, development of ICT will bring more opportunity by reduce production cost and increasing investment. Information and Communication Technology also bring a positive impact to agriculture sector, especially in rural area. Implementation of ICT in agriculture sector raised and introduced for the first time during World Summit on Information Society in 2003 (Kamran, et. al., 2016). In this session, e-Agriculture is introduced to public. E-Agriculture has a purpose to increase farmer's standard of living (Kamran, et. al., 2016).

E-Agriculture is also able to increase standard of living by reducing cost production in agriculture sector, minimize pre-cultivation process and time, and increase the crops. Thus will bring a financial improvement by increasing the farmer's profit. Farmers are easier to access information that will be useful for agriculture sector. Development of e-Agriculture has some obstacles. Masiello-Riome, et. al. (2008) described that 57% respondent has no attention to e-Agriculture. Farmers are still busy and do not have willingness to change the way they cultivate and process the field. High cost in accessing the Information and Communication Technology is also a challenge. Government should develop less cost information access for rural area.

Information access is an important issue for e-Agriculture development. Farmers need following information: (1) Technique and Practise in agriculture (57%); and (2) Market information (33%) (Masiello-Riome, et. al., 2008). Thus, infrastructure is needed to prepare information access. In Yogyakarta, available infrastructure for ICT is telephone network, ISP, and wireless network (Delima, 2016). Implementation e-Agriculture has been integrated with agriculture operation to ease farmer's job, reduce processing time, minimize cost, and prevent environment from hazardous material. Implementation of e-Agriculture with Mobile Driven Extension has been implemented in India and Kenya (Brugger, 2011) by using Information Technology to collaborate with government, research centre, university, and farmer through internet. This model is supported by applying Call Center approach. By using tele-center, user will be helped by an agent. This agent will provide information that user needed, such as: irrigation, pest management, and other information. Research centre, university, and government should be able to update the information and solve user's problem (Brugger, 2011).

E-Agriculture also provides information about market and the usage of web technology extensively (Kamran, et. al., 2016). Farmer needs following information: (1) Fertilizer price; (2) Agriculture technique and practise; (3) Pest management; (4) Cultivation; (5) Irrigation; (6) Post harvest processing; (7) Innovation in agriculture processing (Delima, 2016). This information is supporting Milavanovic (2014) statement that these information is required by farmers: (1) Information on crops: Farmers need some information related with crops and plants; (2) Information on production techniques; (3) Information on production equipment and agricultural inputs to help farmers to know the tools for soil and plant processing; (4) Market information is an information to support farmers selling the crop during harvest time. These information will be helped to design the data architecture by using TOGAF Framework.

2.2. Data Architecture

The number of data for the enterprise are growing. It encourages the enterprise to depend on data, information, and knowledge in order to run the system and gain the benefit from the system. Thus, it needs to manage data and extract the data in order to get the information and knowledge from the data. Integrated Agriculture Information System as a big system also needs data architecture in order to govern the data. Collection, management, and effective use of data, information, and knowledge are essential ingredients to success of IAIS implementation.

Data architecture comprises data structure and its relationship, principle and guideline governing the design and evolution of data overtime (Hoven, 2004). Data architecture for a business enterprise provides the blueprints for the enterprise's data resources by providing the vision, principles, and standards to create, use, and manage it. (Hoven, 2004). Dunn and Grabski (2001) stated the same representation of the data architecture. Data architecture represent how the data stored logically and physically, how data is organized for information system purpose, and data's correspondence with changing tasks are important to task performance (Dunn and Grabski, 2001). Data architecture also provides framework to enable an enterprise to resolve key issued associated with the quality, timeliness, commonality, and accessibility of the data within the enterprise, and to improve the flow of data between systems within the enterprise (Hoven, 2003). Data architecture also provides a guideline not only for transaction purpose but also to help to decide something related with enterprise strategic solution. Thus, data architecture as a part of enterprise architecture should be defined well as a foundation to build information system. TOGAF as an enterprise architecture standard also has guideline to manage and govern enterprise data. A structured and comprehensive approach to data management enables effective use of data to capitalize on its competitive advantages. Some processes in order to develop data architecture: (1) collect data-related models from existing Business Architecture and Application Architecture materials; (2) rationalize data requirement and align with any enterprise data catalogues and models; (3) Update and develop matrices across the architecture; (4) elaborate data architecture views (http://pubs.opengroup.org/architecture/togaf9-doc/arch/chap10.html)

3. Research Methodology

In conducting this research, researchers followed methodologies:

3.1. Initial Study of ICT Development in Agricultural Sector

Initial study was conducted in 2015 by interviewing 77 farmers from Yogyakarta. From this initial study, it found: (1) 75 % farmers in Yogyakarta are 40 years old and graduated from Senior High School; (2) Farmers use smartphone to look information about agriculture; (3) Farmers lack of IT literacy but they have willingness to use the Information Technology in order to increase their productivity; (4) Farmers need information about prices, farming tools and technique, product marketing and sales, land processing technique, and post-harvest product processing (Delima and Purwadi, 2015).

3.2. Developing Vision Architecture, Business Architecture

After identify the farmers structure and required information, researchers starting to develop vision architecture and business architecture (Delima, Santoso, and Purwadi, 2016; Santoso and Delima, 2016; Delima, Santoso, and Purwadi, 2017). From the architecture vision, it determined that supporting organization for Integrated Agriculture Information System is study group. This organization has the following vision Achieving Farmers Welfare through Precision Farming Based on ICT. It has three missions: (1) providing services to develop farmer capacity using information and communication technology; (2) develop Indonesian IAIS for precision farming; (3) establish online community for every agriculture stakeholders (Delima, Santoso, and Purwadi, 2016). Stakeholders for Integrated Agriculture Information System are categorized into four categories: (1) Farmers; (2) Researchers; (3) Public Sector; and (4) Business sector (Santoso and Delima, 2016). Every stakeholders are analysed and grouped into several group based on its power and interest which reflect the participation of each stakeholders in the development of IAIS and interest in implementation of IAIS (Santoso and Delima, 2016).

Developing vision architecture is followed by developing business architecture. From the business architecture, it is determined that IAIS has four main functions: (1) System, Information Technology Infrastructure, and Organization Standardization; (2) Developing, managing, and maintaining application and infrastructure; (3) IAIS Implementation; (4) Management and Organization. (Delima, Santoso, and Purwadi, 2017). There are 10 available services for IAIS: (1) User Registration; (2) Requesting application services; (3) Requesting ICT Services; (4) Tendering services; (5) Requesting services; (6) Requesting information; (7) Information sharing; (8) Consulting; (9) Recording and observing user specific data; (10) Giving agriculture information and knowledge (Delima, Santoso, and Purwadi, 2017).

3.3. Data requirement for Integrated Agricultural Information System

Delima and Purwadi (2015) studied that farmers need information about prices, farming tools and techniques, product marketing and sales, land processing techniques, and post harvesting processing. Farmers and stakeholder in agriculture sector needs some following information: (1) Fertilizer price; (2) Agriculture technique and practise; (3) Pest management; (4) Cultivation; (5) Irrigation; (6) Post harvest processing; (7) Innovation in agriculture processing. Thus, Integrated Agricultural Information System is able to store data about farmers data, farmers community data, farmers farming activity, daily price, farming technique and processing which will be included in the training session and accommodate by expertise from academician, e-commerce as a place to buy and sell agriculture product.

3.4. Set Up Data Architecture for Integrated Agricultural Information System

In this paper, two components of Integrated Agricultural Information System Data Architecture will be discussed, including: (1) Data entity / Data Component Catalogue; (2) and System / Data Matrix.

4. Analysis and Discussion

4.1. Data Entity / Data Component Catalogue

Data entity is a part of TOGAF data architecture. This data entity identify and maintain a list of all data use across IAIS. Data entity also brings clear definition of where data is stored, either physically or logically.

Table 1. Data Entity / Data Component Catalogue

Data Entity	Description	Logical Data Component	Data Category	Physical Data Component
User	Save and record master user data	Master_user	Master	Disk1
Master Category	Save and record master category data	Master_kategori	Master	Disk1
User Category	Save and record master user category data	Master_user_kat	Master	Disk1
Log User Transaction	Save and record user activity transaction log	Log_user_trans	Log	Disk1
Organization user	Save and record personnel data that are involved in Agriculture Information System Study Group	Master_user_org	Master	Disk1
Organization unit	Save and record organization unit data in Agriculture Information System Study Group	Master_org_unit	Master	Disk1
Forum category	Save and record discussion forum category data	Master_kategori_topik	Master	Disk1
Forum topics	Save and record discussion forum topic	Trans_topik_diskusi	Transaction	Disk2
Forum Comments	Save and record forum comments	Trans_komentar_diskusi	Transaction	Disk2
Farmers Community	Save and record farmers community master data	Master_kel_tani	Master	Disk1
Farmers Community Organization Structure	Save and record personnel data that are involved in management farmers community	Trans_struk_org	Transaction	Disk2
Farmers	Save and record farmers personnel data	Master_petani	Master	Disk1
Farmers membership	Save and record farmer's membership in the community / union	Trans_ang_petani	Transaction	Disk2
Crop Morphology	Save and record crop morphology	Master_morf_tanaman	Master	Disk1
Crop Species	Save and record crop species	Master_spesies_tanaman	Master	Disk1
Farming Activity	Save and record farming activity master data	Master_aktivitas	Master	Disk1
Species Activity	Save and record farming activity and its relation with each species	Master_aktivitas_spesies	Master	Disk1
Farmers Activity	Save and record farming activities that are done by farmers	Trans_petani_aktivityas	Transaction	Disk2
Yields	Save and record farmer's yield / harvest	Trans_hasil_panen	Transaction	Disk2
Cropping Calendar	Save and record cropping calendar data	Trans_kalender_tanam	Transaction	Disk2
Tool, material, and Equipment Category Data	Save and record tool and equipment category data	Master_kategori_alatbahan	Master	Disk1
Farming Tools	Save and record farming tools	Master_alat_tani	Master	Disk1
Farming materials	Save and record farming materials	Master_bahan_tani	Master	Disk1
Supplier Category	Save and record supplier category data	Master_jenis_sup	Master	Disk1
Supplier	Save and record supplier	Master_supplier	Master	Disk1
Agricultural Product	Save and record agricultural product	Master_produk_tani	Master	Disk1
Agricultural product price	Save and record daily agricultural product price	Trans_harga_prod	Transaction	Disk1

Data Entity	Description	Logical Data Component	Data Category	Physical Data Component
Agricultural Product Offer	Save and record supplier offering data of agricultural tools, materials, and equipment.	Trans_penawaran_prod_tani	Transaction	Disk2
Agricultural Product Demand	Save and record agricultural product demand	Trans_permintaan	Transaction	Disk2
Agricultural Product Offer Log	Save and record supplier offering log data	Log_penawaran_prod	Log	Disk3
Agricultural Product Demand Log	Save and record demand log data	Log_permintaan	Log	Disk3
Chart of Account	Save and record farmers chart of account	Master_kode_biaya	Master	Disk1
Budgeting	Save and record farmer's production budget	Trans_anggaran	Transaction	Disk2
Budgeting Detail	Save and record farmer's production detail budget	Trans_detail_anggaran	Transaction	Disk2
Realization	Save and record production cost realization	Trans_realisasi_biaya	Transaction	Disk2
Cost Realization Log	Save and record farmer's log activity on realization budget	Log_biaya_keluar	Log	Disk3
Services	Save and record services for Integrated Agriculture Information System	Master_serv	Master	Disk1
Services Request	Save and record request for Integrated Agriculture Information System Services	Trans_permintaan_serv	Transaction	Disk2
Services Activity	Save and record log services activity	Log_activity_serv	Log	Disk3
Training Materials	Save and record training materials	Master_materi_train	Master	Disk1
Training request	Save and record training request from farmers community	Trans_permintaan_train	Transaction	Disk2
Fasilitator	Save and record faslitator detail data	Master_fasilitator	Master	Disk1
Training administration	Save and record training administration data	Trans_pelaksanaan_pelatihan	Transaction	Disk2
Training activity	Save and record log training activity data	Log_aktivitas_train	Log	Disk3
Learning Material	Save and record learning materials data	Master_materi_ajar	Master	Disk1
Learning Material Detail	Save and record learning materials data detail	Master_detail_materi_ajar	Master	Disk1

From table 1, there are 47 tables are involved for Integrated Agricultural Information System. Those 47 data entities are derived based on the information needed by farmers and stakeholder in agriculture sector. Those 47 tables are involved and related to 9 information systems in Integrated Agricultural Information System.

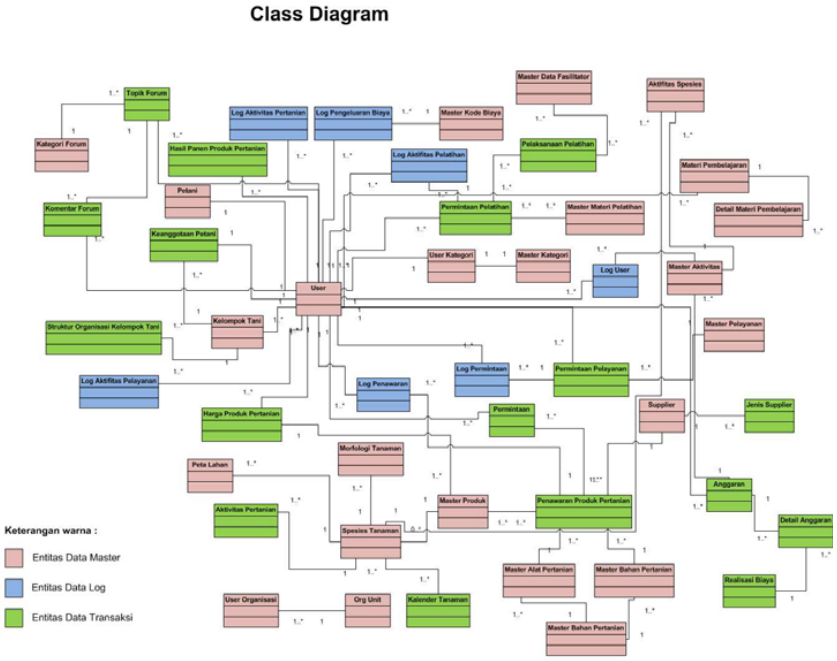

Figure 1. Data Entity Class Diagram

Figure 1 shows the class diagram of the data entities. There are 3 kinds of data entity: (1) Master Data Entity (Colour: Pink); (2) Log Data Entity (Colour: Blue); and (3) Transaction Data Entity (Colour: Green). There are 9 information systems are involved in Integrated Agriculture Information System: (1)

Agriculture Integrated Portal; (2) Farmer and Farmer Community Information System; (3) Farmers and Production Activity Information System; (4) Cropping Calendar Information System; (5) Agriculture e-Commerce; (6) Production Budgeting; (7) Service Information Systems; (8) Training Management System; (9) Learning Management System for Farmers.

4.2. System and Data Matrix

The purpose of the creating matrix of System and data is to depict the relationship between applications and the data entities that are accessed and updated by them. The mapping of the System and Data Entity relationship is an important step as it enables to assign access of data to specific applications in the organization, understand the degree of data duplication within different applications, and the scale of the data lifecycle, understand where the same data is updated by different applications, and support the gap analysis and determine whether any of the applications are missing and as a result need to be created. System and Data Matrix for IAIS can be seen in table 2.

Table 2. System and Data Matrix for IAIS

Application	Application Description	Data Entity
Agriculture Integrated Portal	This system is developed as a portal for integrated agriculture information system. This system also to fulfill farmer required innovation in agriculture processing and technique.	master_kategori, master_user, master_user_kat, master_user_org, master_org_unit, master_kategori_topik, Trans_topik_diskusi, trans_komentar_diskusi, Log_user_trans
Farmer and Farmer Community Information System	This system is developed as a data center for farmers and farmer's membership in community. This system is to help farmer community in order to organize its member and organization. This system is the foundation to build other system.	Master_user, master_kel_tani, master_petani, Trans_struk_org, trans_ang_petani
Farmers and Production Activity Information System	This system is developed to save production activity, such as preprocessing, land processing, harvesting, and post-harvest. This system also helps the government to monitor what farmers are doing. Farmers are able to get also some new technique and practise from expert	Master_user, master_petani_master_kel_tani, master_morf_tanaman, master_spesies_tanaman, master_aktifitas, master_aktifitas_spesies, Trans_ang_petani, trans_aktifitas_pertanian, trans_hasil_panen
Cropping Calendar Information System	This system is developed to administer cropping calendar from each region	Master user, master_user_org, Trans_kalender_tanam
Agriculture e-Commerce	This system is daveloped a gateway for farmers and business sector (private sector) can meet and sell their product. This system is to help farmer to get information about price and supply for product, tools, and materials.	Master_user, master_petani, master_kategori_alatbahan, master_alat_tani, master_bahan_tani, master_jenis_sup, master_supplier, master_prod_tani, Trans_hasil_panen, trans_harga_prod, trans_penawaran_prod_tani, trans_permintaan, Log_penawaran_prod, log_permintaan
Production Budgeting	This system is developed to help farmers manage their production cost.	Master_user, master_petani, master_aktifitas, master_aktifitas_spesies, master_kode_biaya, Trans_aktifitas_pertanian, Trans_anggaran, trans_detail_anggaran, trans_realisasi_biaya, log_biaya_keluar
Service Information System	This system is developed to help farmers get information and services from Integrated Information System, such as information on pest management, innovation in agriculture processing. This system also helps farmers meet the expert.	Master user, master_pelayanan, Trans_permintaan_pelayanan, Log_aktifitas_pelayanan
Training Management System	This system is developed to help farmer community to arrange training for its member. System will help to find the appropiate facilitator based on their expertise and research interest.	Master_user, master_fasilitator, master_materi_pelatihan,master_materi_ajar, master_detail_materi_ajar, Trans_permintaan_pelatihan, trans_pelaksanaan_pelatihan, Log_aktifitas_pelatihan
Learning Management System for Farmers	This system is designed as a tool for farmers to learn about technique and processing practise. It is also help farmers to get information about pest management, new products and techniques. This system is designed for farmers as a tool to learn.	Master_user, master_fasilitator, master_materi_pelatihan,master_materi_ajar, master_detail_materi_ajar, Trans_permintaan_pelatihan, trans_pelaksanaan_pelatihan, Log_aktifitas_pelatihan

Table 2 gives the detail system and its data entity for the system. There are 9 systems are involved and used the following data entity. This system will be developed gradually. The first phase is to build the Agriculture Integrated Portal, Farmer and Farmer Community Information System, and Farmers and Production Activity Information System. Implementation of the system build in the first phase will be followed by farmers training and empowerment to use the system.

5. Conclusion

Based on the analysis, it can be concluded that:

1. IAIS data architecture contains 47 data entities which are categorized into three: (1) Master Data; (2) Transaction data; and (3) Log data.
2. There will be 9 systems are involved in Integrated Agriculture Information System. Those systems are: (1) Agriculture Integrated Portal; (2) Farmer and Farmer Community Information System; (3) Farmers and Production Activity Information System; (4) Cropping Calendar Information System; (5) Agriculture e-Commerce; (6) Production Budgeting; (7) Service Information System; (8) Training Management System; and (9) Learning Management System for Farmer. In the first phase, it will develop agriculture integrated portal, farmer and farmer community information system, and farmers and production activity information system.

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