Smart Agro E-Marketplace Architectural Model Based on Cloud Data Platform

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Abstract. Digital marketplace provides a convenient place for farmers to market farm’s products sales anywhere anytime. If this platform is fully utilized by farmers, it can improve the sustainability of farmers in agriculture industry because it can improve sales volume and fair price for farmers and consumers. However, the current AgroBazaar Online has a few enhancements that can be proposed to improve the acceptance from farmers and consumers. Therefore, there is a need to design the system that can encourage target users to use the system and make the system easy to be used by farmers who relatively have lower ICT literacy. The main requirement to develop intelligent marketing is data to provide intelligent information and services for both farmers and consumers. This project aims to explore data strategies to provide intelligent digital agricultural marketplace based on cloud data platform. This research proposes to develop cloud data platform for e-marketplace based cloud data platform approach. The proposed methodology consists of six phases: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication. This paper proposes an architectural model of agriculture marketplace cloud based on cloud data platform. The architectural model will be used for development of e-marketplace that fulfil the Malaysia’s IR 4.0 policy and National Agro-Food Policy (NAFP).

1. Introduction
AgroBazaar Online is one of e-marketplace in Malaysia. It recorded MYR 3.05 million sales value in 2018 [1]. Compared to overall fruit production is MYR 5.8 billion and vegetable is MYR 5 billion in 2018 [2]. Based on the available data, only very small percentage of agriculture products are sold through e-marketplace by farmers. This might due to low acceptance of e-marketplace as technology for marketing and sales of their products.

Among main issues in agriculture and foods are diversity of products, the deterioration of fresh products within a short time, the limitations in the evaluation of quality characteristics at the final customer, the consumer, the relevance of commodity products, and the distances between areas of production and areas of consumption [3]. Therefore, the right data strategies are needed to provide up to date information for accurate decision making for marketing and predicting product demands.
An alternative to the traditional marketplace is through e-commerce platform as a digital for selling and buying agricultural products. Digital marketplace provides a platform that can be used by farmers to sell their products directly to consumers with higher price and they also can enjoy higher sales volumes.

However, there are a few challenges that need to be addressed by developers to develop e-marketplace. Designers need to design the system that can encourage target users to use the system and make the system easy to be used by farmers who relatively have lower ICT literacy [4]. One way to solve this problem is to develop a Smart Agro-Marketplace that provides friendly user interface and intelligent marketing services.

The main requirement to develop intelligent marketing is data to provide intelligent information and services for both farmers and consumers. Data is the first element in the information value chain and then followed by information, knowledge, decision and actions. Addressing the correct data strategies will produce quality input to produce information, knowledge, decision, and action for marketing. Otherwise, the agricultural marketplace still acts like a basic e-commerce platform without intelligent information and service to help farmers to market their products like professional marketers.

This paper explores data strategies to provide intelligent digital agro-marketplace based on the cloud data platform. Cloud data platform provides business analytical, intelligent information and services [5]. It benefits the farmers to find buyers for their products and predicts the future demands to reduce unsold products. Furthermore, it can increase the acceptance from farmers and consumers to use the digital marketplace.

Agriculture environment fluctuates and it always driven by uncertainty. The need always changes to adapt the current and new situation. This results in data structure changes very frequently where the data table and column can be deleted or renamed anytime due to changes in the data sources. Data sources can come from variety of sources such as web log, user log, IoT devices, and RDBMS.

Thus, it requires a very flexible data platform that can adapt to the changes. There are two possible solutions: Cloud Data Warehouse (CDW) and Cloud Data Platform (CDP) [5].

Like a traditional enterprise data warehouse, CDW architecture has relational data warehouse and Extract/Transform/Load (ETL) process. The relational data warehouse is responsible to store, process and service the data to the end-users.

CDP is a platform to ingest, store, process and make data available for analysis using layered architecture. The CDP architecture consists of four layers: ingestion, storage, processing and serving layers.

CDP differs from CDW in two ways. First, CDP uses different design approach where designing for data platform does not need to provide schema for the incoming data. The approach eases handling of schema changes.

Second CDP uses different data processing approach. CDP data processing approach provides a more flexible mechanism to handle large semi-structured data set using Apache Spark. Apache Spark provides modular and reusable code which is faster for data processing because it uses machine learning to make complex code simpler. Therefore, CDP brings better flexibility and better performance compared to CDW.

2. Related Work

There are a few initiatives that embark digital marketplace or electronic marketplace in developed and developing countries. Even in least developed country such as Uganda, the digital marketplace has been initiated [4]. In developing country such as China, the digital marketplace is known as Shouguang Vegetable Trading Market Online (SSVTMO) a B2B marketplace [6]. Another developing country is South Africa that already adopts e-marketplace by majority of key decision makers in the agricultural industry. In developed countries such as Germany, Denmark, and Finland, they are early adopters of advanced farming system to achieve precision farming practices [7].
[8] proposes a digital marketplace to support agricultural sustainability that integrates the innovative financial solution into broader agriculture’s ecosystem. The model connects farmers, landowners, investors, and consumer into a platform. It promotes transparency, empowerment, resourcefulness, and public engagement in agriculture in a platform where business transactions can be done conveniently at anytime from anywhere.

An Electronic Agricultural Marketplace in Uganda has been developed to technically assist unsophisticated and even illiterate users, to limit communication due to airtime costs, to eliminate cultural resistance in adopting electronic markets, and to reduce high travel costs [4]. The system uses Short Messaging Service (SMS) to provide simple transaction method to place bids (buy) and asks (sell) that is controlled from centralized nationwide database. SMS is used because it is more widely available by small farmers in Uganda. Compared to [8], this solution looks quite outdated which does not utilize internet-based services. SMS method is suitable for marketplace in Uganda as it has low internet penetration rates.

In Malaysia, AgroBazaar Online is launched in 2014, a pioneer national e-marketplace project that provides online Agro-food community [9]. The system is developed and managed by Malaysia’s Federal Agricultural Marketing Authority (FAMA). Through this e-marketplace, any farmer and entrepreneur can be invited to become a seller to create their own online bazaar. The AgroBazaar is a multi-tenant e-commerce application that provides basic e-commerce transaction.

3. Towards Intelligent Cloud E-Marketplace
In Industry Revolution (IR) 4.0, Internet is the main technology enabler to address these issues comprehensively. Service-oriented architecture can integrate various technology such as cloud computing and artificial intelligent to provide intelligent services in marketplace for farmers. Thus, it will attract participation from farmers, individual and commercial buyers to use the e-marketplace. Artificial intelligent can bring more intelligent services such as for prediction whether the trade will be successful by using machine learning technique. However, the lack of data is the main hurdle to achieve it [4].

The implementation of IR 4.0 requires integration of various technologies and techniques including CPS, cloud computing, blockchain, industrial information integration and other related technologies. Architectural approach based on Cloud Service Oriented Architecture has many potentials to improve the current e-marketplace from basic e-commerce system to provide intelligent services for farmers and buyers such as price suggestion service, product finder service, and sales analytics service.

Despite huge potential of Internet, Malaysian farmers have not fully utilized in this technology to improve their agriculture products sale. Most farmers depend on traditional marketplace to market their agricultural products. Traditional marketplace is the most popular one stop centres of agricultural products where farmers are selling their crops and products directly to consumers with higher price and consumers can buy with lower price [10]. However, the sales volume is relatively small because most of the buyers come from local communities.

The only Malaysian digital marketplace is AgroBazaar Online portal [9]. The portal is open to any Malaysian agro-food traders, producers, and farmers to create their own online store in the portal. Individual and commercial farmers can buy any product in small and bulk purchase. Discounted price is given for bulk purchase.

Malaysian Agriculture aims to achieve IR 4.0 which transformation from the information age in third industrial revolution to the age of Cyber Physical System (CPS) [11]. The transformation to IR 4.0 needs to integrate various technologies and techniques including CPS, cloud computing, blockchain, industrial information integration and other related technologies. Choosing the right advanced ICT will ensure the success of IR 4.0 including in agricultural industry. There are a few challenges and issues at each data chain stages to adopt IR 4.0 in Malaysia [12]:

a) Data availability, quality, and formats at the data capture stage
b) Quick and safe access to data and costs at the data storage stage
c) Safety, agreements on responsibilities and liabilities at the data transfer stage
d) Heterogeneity of data sources, automation of data cleansing and preparation at the data transformation stage

e) Semantic heterogeneity, real-time analytics, scalability at the data analytic stage

f) Ownership, privacy, new business models business models at the data marketing stage

Agricultural industry needs the right technology from state-of-the-art in cloud computing to boost the production and sales of agriculture products [3]. Cloud computing platform allows farmers and traders to communicate to each other to form dynamic trustable and secure relationship among them. Among the main concerns in agriculture supply chain is communication of information between stages of chain to facilitates communication between farmers and consumers. Cloud data platform provides business analytics through intelligent information and services [5].

E-marketplace uses Digital Platform Environment (DPE) that acts as intermediary to facilitate the interaction between sellers and buyers using EDI and Internet [13]. It provides a few electronic commerce functionalities such as product catalogues with item characteristics and prices, price bidding, price negotiation, payment settlement, shipping, reporting, insurance, financial support and consultancy. The common method to bring these features is intelligent software agents. The intelligent software agent provides personalized services for users based on buyer’s behaviour.

4. Proposed Work

Figure 1 shows the proposed Smart-Agro e-marketplace based on CDP. Buyer and seller are two main users of the system. The system basically consists of two main components the Smart-Agro E-Marketplace Portal and Smart Marketing Recommendation System.

The e-marketplace portal will be used by sellers and buyers to sell any item. When a seller creates product catalogue, it will provide seller’s data to the CDP. When a buyer browses product in the product catalogue, it will provide the information that user needs from the CDP. When the user purchases any items through shopping cart, it will record the transactions of that buyer in the CDP. Therefore, there are three types of data stored in the CDP: what sellers are selling, what users are looking, and what buyers have bought. These data will be ingested in CDP for further processing step to produce buyer recommender information for buyers and seller recommender information for sellers.

In the Smart-Agro E-marketplace CDP, there are four data layers to produce buyer recommender and seller recommender:

a) **Data Ingestion Layer.** This layer is responsible for connecting to the source system and bringing data into the data platform in streaming and batch mode. Both modes can improve the accuracy of analytical result. This layer will handle mapping data types, automation and data volatility.

b) **Data Storage Layer.** This layer is responsible for keeping the data for long term and short term consumption to support batch and streaming data ingestion. The layer has slow and fast data storage. Slow storage is the main storage for archive and persistent data where data will be stored for days, months and often years or even decades. Fast storage is for accommodating low latency read/write operations on a single message. Fast storage is more expensive than slow storage; therefore, segregating data to fast and slow storage can reduce data storage cost.

c) **Data Processing Layer.** This is where all the required business logic is applied that contains data validations and data transformations. It also provides ad-hoc access to the data in the data platform. This layer will include data processing stages to transform raw data and unrefined data coming from the data storage layer to well-defines and validated data products that can be used for analysis.

d) **Data Serving Layer.** This layer delivers the output of analytics processing to the various data consumers through relational data structure and SQL via data warehouse and without data warehouse.
The proposed Smart-Agro E-Marketplace Architecture has a few advantages. First, it has clear separation between portal platform and data platform that makes it independent from each other. Second, the four layers data platform architecture provides loosely coupled integration between the system components. This approach brings significant flexibility to mix and match different cloud services or tools according to business requirements.

5. Proposed Methodology
This paper proposes to adopt design science (DS) research methodology based on Peffers et al. [14]. The main objective of DS research is to ensure successful artefacts such as constructs, model, methods, instantiation, and any designed object [14]. This research aims to produce a model of data to be used for digital marketplace that needs data of agriculture products and related data for development of product finder services and price suggestion service. This is foundation problem that needs to be addressed properly in order to develop digital marketplace that can provide effective marketing and sales marketplace for farmers, traders and consumers.

The research methodology has six main phases: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication.

Problem identification is first research stage to identify data requirement for agricultural e-marketplace using literature review and expert interview. In literature review, scientific articles will be reviewed to find current problem of agricultural e-marketplace and the solutions. The limitation and strength of current solution will be examined that might be useful to be adopted in this research.
Interview with practitioners and experts in the field of agricultural product marketing such as the Federal Agricultural Marketing Authority (FAMA) will be conducted to understand their opinion and experience that might be useful to be considered in the design of agricultural cloud data platform. About six marketing officers of FAMA will be selected as respondents in the expert interview. Their opinions are needed to verify the source and type data and information for agricultural marketplace. This is a critical stage that needs to be carefully addressed to ensure accurate input for the next research stage.

The second stage is to identify the objective of the solution. Based on the identified data and information requirements, the objective of solution will be identified. This is to ensure the applicability of objective to the participating organizations.

In the third stage, a solution will be developed in the form of architecture of agricultural e-marketplace using cloud data platform design. Data from literature review and expert review will be used as input to develop the artefact.

Next state is refining the hypothesis to be more constricted and precise. Refined hypotheses are evaluated using laboratory experiments. The newly designed artefact will be compared to existing solutions.

Expert survey is performed on the general hypothesis to show that there is general interest in the solution. The same respondents will be called in the expert survey. The survey might contain the question: “Do you think the presented artefact provides a viable solution to the problem?” Additionally, the survey might include questions that are relevant to the problem, even though relevance has already been tested during problem identification.

6. Conclusion
This paper presents a proposed architectural of Cloud Data Platform for Smart-Agro E-Marketplace to produce intelligent buyer and recommender for selling and buying product in e-marketplace. This brings benefit to both buyers and sellers. The system can provide them an intelligent information such as “what is right product to sell for sellers” and “what is the right product to buy for buyers.” The information is produced in four-layer cloud data platform. The result can be used to improve farmers sales volume and profitability by improving marketing and pricing strategy using smart cloud data platform. Furthermore, the architectural model will be used for development of e-marketplace that fulfil the Malaysia’s IR 4.0 policy. The future will include the design to convert source text files into a more efficient binary formats and to convert business logic into data processing algorithm. The result will be used to prepare the implementation of Smart-Agro E-Marketplace.

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