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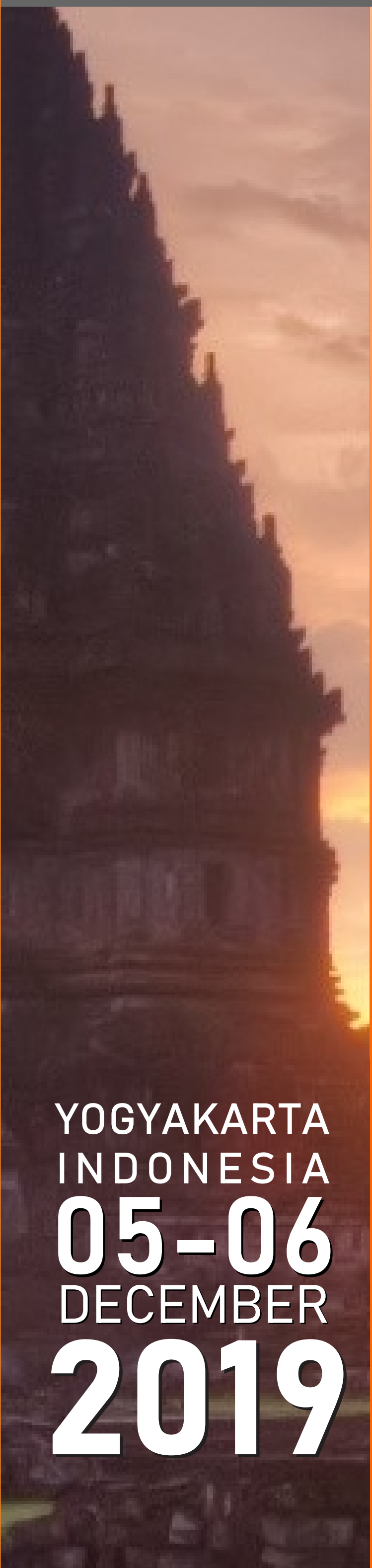
"The Future & Challenges of Extended Intelligence"



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Preface

Nowadays, the development of algorithms and technology that bases on the progress of artificial intelligence is making considerable progress. Various applications can support multiple sectors of human life. In the past, it was only a dream, which was then outlined in an idea, could a machine think? If the machine could think, then how? But if it couldn't, why couldn't the machine think? What is the definition of thinking and mind?

Various definitions and implementations so that machines can think are attracting the thinking of engineers and scientists. From this, it states in the machine's ability to learn or understand from experience entered to be recognized by the machine. Then the process is then formed to understand the contradictory and ambiguous messages so that the machine can respond quickly, precisely, and well to the new situation. So this results in the process of reasoning in solving problems and solving them effectively.

Various perspectives on the definition of intelligence then become possible to make machines intelligent like humans think. These perspectives encourage the field of artificial intelligence in conducting studies to make computers able to do things as well as humans do with various approaches to symbolic programming, problem-solving, and searching. From a business perspective, artificial intelligence is seen as a collection of compelling and methodological tools in solving business problems.

Basically, artificial intelligence consists of 2 main parts, namely the knowledge base and inference engine. The knowledge-base contains facts, theories, thoughts, and component relationships with one another, while the inference engine includes the ability to draw conclusions based on experience related to the representation and duplication of the process through machines. Artificial intelligence is developing continuously until now, and more and more objects can be resolved by artificial intelligence.

The development of artificial intelligence encouraged this conference to take the theme "The Future and Challenges of Extended Intelligence". This conference brought together academics, students, engineers, scientists, practitioners, and people working in the world of artificial intelligence to share their knowledge to increase the realm of artificial intelligence.

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Agriculture Spatiotemporal Business Intelligence using Open Data Integration

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***Abstract*—Business Intelligence is a technology for collecting, transforming, and presenting data for analysis as a tool for supporting decision making. Business Intelligence using Data Warehouse, Multidimensional data, and Online Analytical Processing (OLAP) has proven to be useful for obtaining information and knowledge relevant to the business. Nowadays the development of the internet with Web 2.0 model is increasing the availability of data over the internet. Linked Open Data (LOD), Open Data, and Open Government Data is constantly growing, producing a large amount of valuable data in the form of semi-structured data, flexible and machine-readable. Data sharing on agricultural production is one of the requirements for the best of analysis of agricultural production, but most of the data is still in the format of 2/3-stars open data and does not yet have spatial data that facilitates analysis based on spatial dimensions. The emerging open data concept makes the data warehouse more dynamic and can accommodate external data. Spatiotemporal support in open data also enables a more sophisticated analysis of data with spatial queries. This research develops tools to integrate agricultural data originating from the Village and Rural Area Information Systems (SIDeKa) that has open distributed data, a service-oriented approach, and spatiotemporal data. This paper also describes the design of business intelligence and multidimensional data for analysis and decision-making tools that enable spatiotemporal and non-spatial based analysis. This paper also highlights the opportunities for scaling and sustaining the initiative.**

Keywords—Business Intelligence; Open Data; Agriculture; Spatiotemporal Data Warehouse, Decision Support System;

I. INTRODUCTION

The Government of the Republic of Indonesia has a 2015-2019 Medium Term Development Plan (RPJMN) that focuses on development in the agricultural and maritime sector and humans to achieve national food sovereignty by using information and communication technology support. In Indonesia, agricultural development related to village development because the location of the agricultural land is mostly in the village. At present, the village is still the largest producer of agricultural and livestock products. The agricultural and livestock products give a significant contribution to the Gross Domestic Product. During the three-year Working Cabinet period (2015-2017), the performance of the agricultural sector showed encouraging results by contributing 10.20% of the total GDP to the national economy and the growth rate in the second quarter of 2017 was around 4.31% [1]. Farmers are a profession owned by most people in the village and in Indonesia, around 38.97 million in 2014. Although many residents work as farmers and produce agricultural products but the economic condition of farmers is still below the level of prosperity, Indonesian Central Bureau of Statistics estimates the income of farmers is only around 1.5 million rupiahs which is cheaper than the Jakarta's regional minimum wage which can reach more than 3 million rupiahs.

Based on the farmer's perspective, the agricultural cycle has three stages, namely: (1). Pre-planting, this cycle contains processes: loan lending, date determination, land selection, seed selection. (2). Care and harvesting, this cycle contains processes: soil preparation and cultivation, management of planting, water management, and fertilization, and the provision of pesticides. (3). Post-harvest. This cycle contains the process of marketing, transportation, packaging, and processing of agricultural products [2].

Indonesia as an agrarian country is often faced with problems and challenges to achieve sustainable food security. This relates to many aspects of economic, social, political and environmental aspects. Identifying these problems and challenges can be done through the analysis of food supplies and food demand. Information on food supplies is currently obtained from the Central Bureau of Statistics and the Ministry of Agriculture. At present Indonesian Central Bureau of Statistics and the Ministry of Agriculture do not yet have an effective and cheap way to obtain data and predict the agricultural data for decision making related to agricultural production and fulfillment of domestic needs. Many questions have to be predicted regarding the fulfillment of domestic food needs related to spatiotemporal, for example: (a) how much rice, corn, and soybeans production for the next 2 months, in district X, in sub-district Y? (b) How much rice production failed due to pests this month, in a certain location aggregated on a provincial, national basis and still other questions? These questions can be answered in several ways, such as (a) data collection at the level of rice fields/parcels, this method has a high degree of accuracy, but this method must be carried out periodically and in a fairly short range, this cannot be implemented considering that there are quite a lot of resources. (b) the use of satellite imagery to estimate rice crop productivity [3]. The use of satellite imagery requires expensive costs, especially if the remote sensing process is carried out periodically in the short term

Various ways have actually been done to integrate agricultural data in Indonesia, one of which is the use of One Data Indonesia which can be accessed at http://data.go.id, including agricultural data. But the data is still general data and not real-time, which is not detailed such as agricultural production at a certain time, in which location, etc. Data does not include agricultural progress information, such as information on fertilization, pesticide administration, failure or failure of harvests, etc. so it is difficult to be able to answer important questions as in the question above.

The Open Data concept attracted the attention of researchers and governments of countries in the world after the 5-star deployment scheme was published to open data. Many state governments publish their data so that they can be accessed easily, these countries include Taiwan, Australia, UK, France, etc. Open Data Government can provide benefits in terms of transparency, public service improvement, Innovation, and Economic Value, and Efficiency. Open Data has also been known in Indonesia, which was marked with a ranking of 61 from 94 countries, with a score of 25% from the Global Open Data Index rating. The 5 star rating of Open Data is divided into (a) 1-Star: Data is available on the web (whatever format) but follows the open license rules, (b) 2-Stars: Data is available as machine-readable structured data (eg excel instead of image scan), (c) 3-Stars: Data available as 2-Star plus with non-proprietary formats (e.g. CSV, instead of Excel), (d) 4-Stars: Data available as 3-Stars plus use open standard of W3 to identify things, so that people can point at your stuff, and (e) 5-Stars: Data available as 4-Stars plus can link to people's data to provide context (Linked Open Data).

This paper will explain the design and development of the Business Intelligence system in agriculture called Agriculture Spatiotemporal Business Intelligence that integrates data from the agricultural module of the Village and Rural Area Information System (SIDeKa) that has been developed and implemented in previous research. Agricultural data from the Information System are publicly published using Web Services that can be aggregated from the village level and continue to supra villages, namely: districts, provinces, and nationalities that have spatiotemporal data can be used as decision-making tools related to regional and national food security.

II. Related Works

A. Business Intelligence and Open Data

The use of Business Intelligence (BI) has grown rapidly in the last 20 years with the increasing number of commercial and open-source tools that can be used to build BI applications, including for e-government purposes. An important concept behind Business Intelligence is the use of a Data Warehouse, which has classically been defined as an assembly of subject-oriented, integrated, non-volatile, and time-varying data used to support crucial decisions making [4].

BI and DW have been widely used in various fields of decision making, including the government. Several designs for DW have been developed, the e-GovMon Data Warehouse is one of the answers to a data repository for e-Government. This research develops DW for e-Government using open source technologies. This DW architecture uses the PostgreSQL database, has data sources from the transactional e-government data source, and an ETL tool to extract and fill the data [5].

On the other hand, the improved internet condition is shifting the way in which Business Intelligence or data warehouses are designed, used, and queried. With the introducing of the new initiatives such as Open Government and Open Data, many institutions want to share their multidimensional data cubes and make them available to be queried online. The famous data cube vocabulary for RDF is QB, and QB becomes the W3C standard to publish statistical data. But the QB has numerous limitations to fully support the multidimensional model. The new vocabulary it is called QB4OLAP then emerges to overcome the limitation of QB. QB4OLAP has several features that very useful in OLAP, like slice, dice, rollup, and drill down using SPARQL queries. The output of the research is also a tool that could convert data from relational DW/Multidimensional data into RDF. This research also creates a solution to a real case of Uruguay, in the context of health services, housing, and citizen salary [6].

Likewise, Asano et al. develop a technique for creating a website for publishing open data by focusing on the case of the Ministry of Economy, Trade, and Industry of Japan. This research design two sites for publishing open data: searching site for LOD, and a data catalog site. The former feature allows users to search the data they needed, and the latter could be used to connect data with the found data. This research also established a data catalog place personalized to the needs of the organization. Then, the research extracted a large amount of metadata from the individual open data and put it on the site as data for decision making [7].

Furthermore, Mijovic et al. propose ESTA-LD (Exploratory Spatio-Temporal Analysis) tool to publish and share Open Government Data in Spatio-temporal analysis sense. This tool gives an impressive reporting feature that could address some issues of the Linked Statistical Data, such as visualizing statistical data with geographical dimensions, reporting many different measures, create statistical maps, comparing some measures of different time through regions. This publishing technique is using aggregation or integration from many data sources and using the construction of some information mashups. This tool could be used as a basis for policy planning, regulations, and prediction. This research also discusses the modeling aspect to represent statistical, temporal and spatial data in Linked Open Data format. This research gives the contribution of the delivery of new open-source tools for retrieving, querying, and analyzing of statistical Linked Open Data that is accessible through a SPARQL endpoint [8].

Additionally, research by Stasiewicz et al. develop a set of tools to take advantage of linked data created from the integration of statistical open marine datasets. These datasets are coming from marine rescue digital services. This research also points out that creating digital public services from open data is of significant concern to the government, industry, and academia. In the area of Linked Open Statistical Data, the form of multidimensional data cube are the first-rate data that support digital public services [9]. Furthermore, research conducted by Maliappis et al. about OLAP Data Warehouse for agricultural policy. This study aims to integrate various agricultural data sources so that individuals or industries can access the information they need. Data related to agriculture is very important for agricultural policy research. Based on available data, policymakers will make appropriate regulations for the sustainability of agriculture. But agricultural data is not a small amount of data. There are various diverse sources of information, and there are many dimensions and historical data from various years. Besides, agricultural data has many hierarchies, whether geographical or agricultural products. The data is stored with different storage models, this is not suitable for advanced analysis. The data is needed by various types of users in the interest of getting the appropriate information. Therefore a more suitable approach is required in order to produce information more efficiently, the data warehouse is the most suitable tool for this purpose. This study uses Pentaho Data Integration for ETL processes and uses free RDBMS as its database [10].

The Australian Government has a program to protect, improve or assess the environment in a yearly manner. The program has a diverse range of plans including land supervision practices to protect the Great Barrier Reef, assessments of farming efficiency, and the controlling of conservation water to protect critical wetlands in the Murray-Darling Basin. The Australian Government tries to improve its service effectiveness and its productivity through the Digital Earth Australia (DEA) program which uses big data technology via satellite data. DEA program develops Australian Geoscience Data Cube and published as an Open Cube [11].

Furthermore, Statistical Data for decision support published on the web has been enhanced with the emerging 5-Stars Open Data, using linked data. Salas et al. find out two techniques on how to extract, represent and publish statistical data using linked data. This research develops the OLAP2DataCube tool that could transform big analytical databases into RDF that represent OLAP and statistical data efficiently. These two techniques use the RDF Data Cube Vocabulary and linked with the dimensions (such as cities, regions or states with GeoNames) and could be integrated independently. The user interface and visualization have been published on dados.gov.br. The dados.gov.br has over 1,300 historic information collections that expose government activity between 2003 and 2010. The dataset includes more than 4 million annotations of administration in Brazil. This site has initially more than 30 million RDF triples linked to DBpedia and GeoNames [12].

Finally, research by Klimek, et al. describe how the Czech Social Security Administration (CSSA) publishes their pension statistics as Linked Open Data (LOD). The official statistics have become like part of their daily operations. The pension statistic data is modeled using the Simple Knowledge Organization System (SKOS) vocabulary and the RDF Data Cube Vocabulary (DCV). The data also published as CSV files in order to be used by the user without the knowledge of

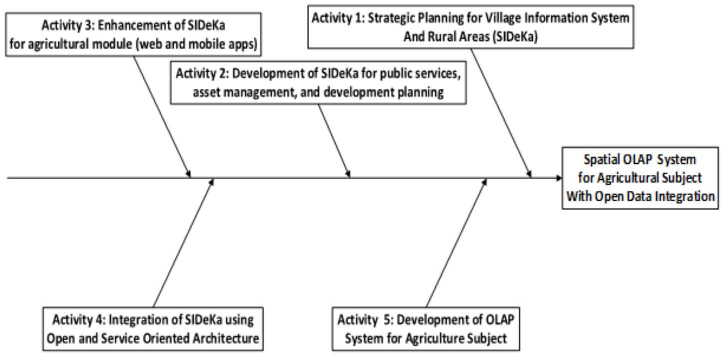

Fig. 1. Research Activity

Linked Open Data. The data also could be visualized from SPARQL endpoint that query from RDF data dumps using IRI dereferencing for semantic web technologies. This research also shows that the data could be reused in applications and could contribute to statistical measures in mixture with other LOD [13].

On the other hand, research about spatiotemporal DW grows with the popularity of mobile, IoT, and network sensor technology. The mainstream for spatiotemporal DW is a trajectory DW that organize and analyze trajectory data

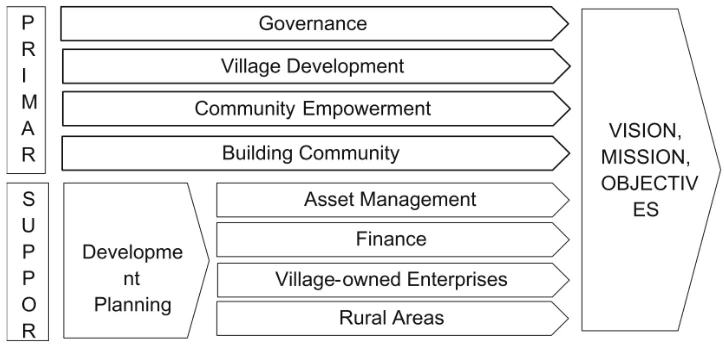

Fig. 2. Village Value Chain

collected from moving objects and can be exploited using the OLAP and data mining techniques [14]. Wagner et al. proposed Trajectory DW enriched with semantics. The unit of movement is the (spatiotemporal) point endowed with several semantic dimensions, including the activity segments, the transportation means, the mobility patterns, and categories and hierarchies [15,16]. Vaisman et al. developed the Mobility Data Warehouse for mobility analysis. The DW store moving obsx2wjects data that generally come in the form of long sequences of spatiotemporal coordinates (x, y, t), and store the positions of moving objects at any point in time. These are data warehouses that contain MO data that can be analyzed in conjunction with other kinds of data (e.g., spatial data), for instance, a road network, altitude data, and the kind [17].

The all mentioned related works show that, some of the e-government project [7,12] provide good result for using open source software, [8,9,10,13] have significant contribution on publishing, sharing, and querying data using linked open data, but does not include spatiotemporal dimension in their DW that system may lose some opportunities to execute complex query with impressive and intuitive results. On the other hand, the research [11] has significant findings in spatiotemporal analysis and visualization with linked open data, but it still relatively new technology where standards for representing spatial and temporal concepts are still shaping up. The research [14-17] has excellent findings in spatiotemporal DW that become major references for this research.

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III. RESEARCH METHODOLOGY

This research held with some related activities, as can be viewed on a fishbone diagram in Fig. 1. This research is comprised of six activities. The detail of the activity is:

Activity 1, Villages and Rural Areas information system strategic planning implemented in phases: (1) Literature Review. (2) Data collection and business processes analysis in the organization. The business processes are analyzed with analysis tools, i.e.: Porter's Value Chain [18], Business Process Analysis [19], Enterprise Architecture modeling, using phases in TOGAF ADM methodology[20]. This approach is complete and phase is the Value Chain Diagram on Village [22], shown in fig 2.

Activity 2, Development of Village Information System and Rural Area (SIDeKa) for public services, asset management, and development planning is a development for the primary business process in the village.

Activity 3, Enhancement of SIDeKa for the agricultural module is a system enhancement with a new feature on the web and on mobile applications. This new feature is trying to reduce chain within farmers and market and within farmers and supplier, and also capture the production process of agriculture, including the spatial attributes of the field, The screenshot of the user interface for the system shown in fig. 3.

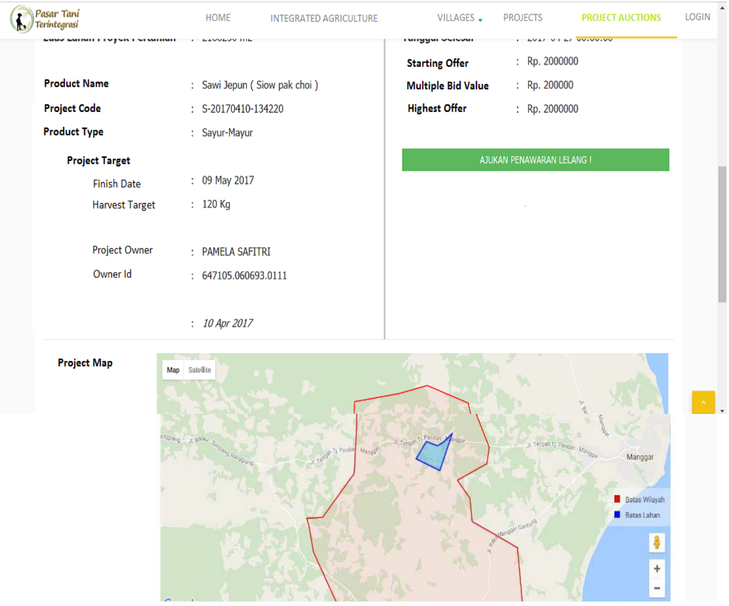

Fig. 3. Screenshot of Agriculture SIDeKa apps

Activity 4, Integration of SIDeKa using Open and Service Oriented Architecture is an ETL process to integrate data from multiple data sources using REST API Web Service.

Activity 5, Development of OLAP System for Agricultural Subject is a development of OLAP Business Intelligence that performed with the following steps: (1) Identify the user requirement, define, refine, and prioritize goals (2) Presenting a star/snowflake schema based on facts, measure, dimensional model, and introduce new measures that captures both the temporal and spatial dimensions, (3) Design model/architecture for Extract, Transform and Loading with open data integration, and (4) Implementing the OLAP Business Intelligence System.

IV. RESULT AND DISCUSSION

Spatiotemporal Business Intelligence using open data integration performed with the following steps:

(1) Identify the user requirement, define, refine, and prioritize goals. The group of user that will be using the system is:
(a) Executive: Ministry of Agriculture, Regent, Mayor, Sub-district head, etc.
(b) Business Agency: National Logistics Agency
(c) Other stakeholders: Citizen, Society
Goals: Strengthening the food availability and handling of food security.
The query that operationalizes the goals:
1. Q1: Determine how many tons of production of rice, corn, and soybeans produce **during** the fasting month and Eid al-Fitr this year in certain areas in certain districts?
2. Q2: Determine how much vegetables, fruit, and herbs need to be supplied from the nearest village to fill the lack of rice, corn, and soybean production in this year's fasting month for certain villages?
3. Q3: Find out how much rice, corn, and soybeans farming loss in currency suffered by Palu City because of the earthquake? if given certain polygon areas affected by the earthquake on Sept 6, 2018?
4. Q4: Find out how large the agricultural area of rice, corn, and soybeans affected by the eruption of Mount Agung in Bali on November 27, 2017, with a radius of 20 km?
5. Q5: Determine how much seed and fertilizer needs for rice, corn, and soybeans farming at the beginning of the first planting season this year for farmer groups in Sleman district?

(2) Presenting multidimensional schema based on facts, measure, and dimensional model and introduce new measures that capture both the temporal and spatial dimensions is shown in fig. 4.

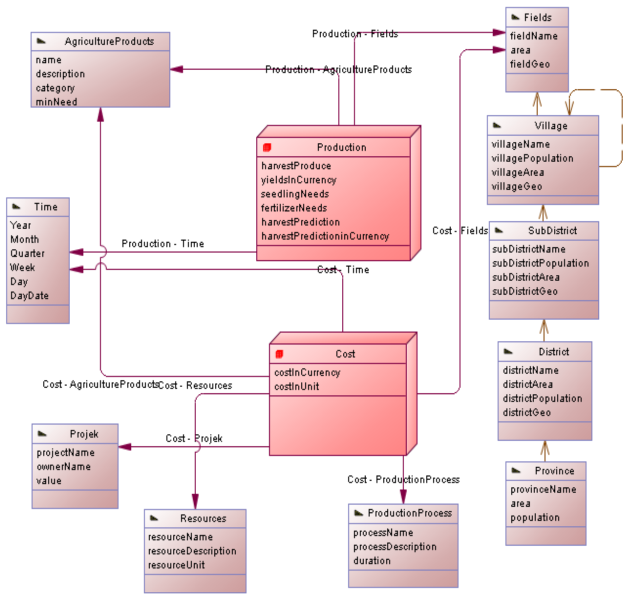

Fig. 4. Multidimensional Model

(3) Design model/architecture for Extract, Transform, and Loading (ETL) with open data integration. The ETL process is an integration of multiple data sources to create an enterprise data warehouse. Transactional data from SIDeKa will be integrated into the data warehouse using the open data concept. This integration built using REST API web services that run on the top of the SIDeKa server. The Web Service is established using PHP language with codeigniter 3.0.6 framework. Each SIDeKa server has several different endpoints. Each endpoint will be responsible for one function, and each of these functions will return a value/values from the transactional database in SIDeKa using JSON formats. The sample of data from the transactional system in triples format, shown in table 1

Table 1. Sample Data from the transactional system

Subject	Predicate	Object	Start Time	End Time
B001	hasDistrict	Sleman		
B001	hasVillage	Purwomartani		
B001	farmersGroup	MakmurTani		
B001	LocatedIn	Polygon([10.34512, 15.1231], [15.674 15.675],….)		
B001	plantBy	Duryono		
B001	hasPlant	Soybeans		
B001	hasArea	2 (ha)		
B001	progressPlan	AccessToCredit	10-10-2018	11-10-2018
B001	progressPlan	CalendarDefinition	12-10-2018	12-10-2018
B001	progressPlan	CropSelection	13-10-2018	13-10-2018
B001	progressPlan	LandPreparation	14-10-2018	16-10-2018
B001	progressPlan	InputManagement	17-10-2018	20-10-2018
B001	progressPlan	Fertilization	27-10-2018	03-11-2018
B001	progressPlan	PestManagement	03-10-2018	25-11-2018
B001	progressPlan	Harvest	26-11-2018	02-12-2018
B001	products	8 (ton)		

Table 2. List of web service endpoint

No	*Endpoint*	Source Table
1	../getAllMember	lppmuajy_sidekapasartani.member
2	../getAllLelang	lppmuajy_sidekapasartani.lelang
3	../getAllPenduduk	lppmuajy_sidekapasartani.tbl_penduduk
4	../getAllTawaranLelang	lppmuajy_sidekapasartani.tawaran_lelang
5	../getAllProduct	lppmuajy_sidekapasartani.produk_pertanian
6	../getAllProgress	lppmuajy_sidekapasartani.progress_proyek
7	../getAllProyek	lppmuajy_sidekapasartani.proyek_pertanian
8	../getAllTipeProduk	lppmuajy_sidekapasartani.ref_tipe_produk

(4) Implementing the OLAP Business Intelligence System. OLAP Business Intelligence System for Agricultural Subject is designed and developed using the architecture shown in fig.5.

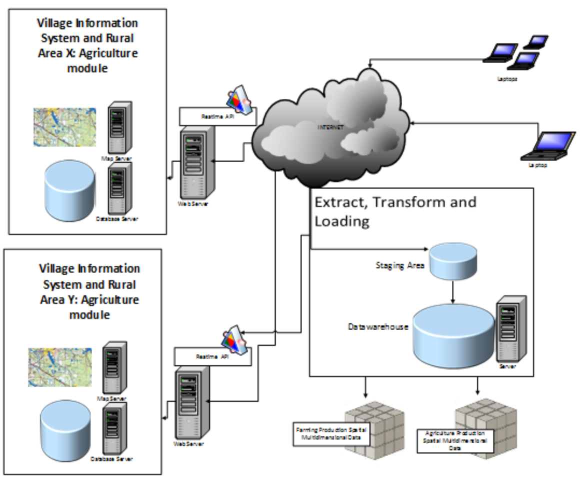

Fig. 5. System Architecture

The SQL Query and the visualization of the report are shown here:

1. Q1: Determine how many tons of production of rice and soybeans produce **during** the fasting month and Eid al-Fitr this year in certain areas in individual districts?

SQL Query:
```
SELECT AP.Name, SUM(harvestProduce)
FROM Production P, AgricultureProducts AP, Time T,
Fields F, Village V, SubDistrict SD, District D
WHERE P.ProductKey = AP.ProductKey AND P.TimeKey =
T.TimeKey AND P.FieldKey = F.FieldKey AND
F.VillageKey = V.VillageKey AND
F.SubDistrictKey=SD.SubDistrictKey AND SD.DistrictKey
= D.DistrictKey AND ST_Within(F.PolygonArea,
ST_GeomFromText(Polygon(10.45 15.12, 11.46 15.30,
12.56 15.30, 11.45 15.30, 11.42 15.30) AND T.Date
BETWEEN '6-MAY-2019' AND '6-JUN-2019' GROUP BY
AP.Name
```

2. Q2: Determine how much vegetables, fruit, and herbs need to be supplied from the nearest village to fill the lack of rice, corn and soybean production in this year's fasting month for certain villages?

SQL Query:
```
SELECT AP.Name, SUM(harvestProduce)
FROM Production P, AgricultureProducts AP, Time T,
Fields F, Village V, Village VS
WHERE P.ProductKey = AP.ProductKey AND P.TimeKey =
T.TimeKey AND P.FieldKey = F.FieldKey AND
ST_Distance(V.villageGeo, VS.villageGeo) <= ( SELECT
MIN( ST_Distance(V.villageGeo,VS.villageGeo) FROM
Village V2 and Village VS1 WHERE V2.villageKey =
VS1.villageSKey ) AND F.VillageKey = V.VillageKey AND
T.Date BETWEEN '6-MAY-2019' AND '6-JUN-2019'
GROUP BY AP.Name
```

3. Q3: Find out how much rice, corn, and soybeans farming loss in currency suffered by Palu City because of the earthquake? if given certain polygon areas affected by the earthquake on September 6, 2018.

SQL Query:
```
SELECT Ap.Name,
SUM(harvestPredictionInCurrency)FROM Production P,
AgricultureProducts AP, Time T, Fields F, Village V,
SubDistrict SD, District D WHERE P.ProductKey =
AP.ProductKey AND P.TimeKey = T.TimeKey AND
P.FieldKey = F.FieldKey AND F.VillageKey =
V.VillageKey AND F.SubDistrictKey=SD.SubDistrictKey
AND SD.DistrictKey = D.DistrictKey AND D.districtName
= 'Palu" ST_Within(F.PolygonArea,
ST_GeomFromText(Polygon(10.45 15.12, 11.46 15.30,
12.56 15.30, 11.45 15.30, 11.42 15.30) AND T.Date
BETWEEN '6-SEP-2018' AND '6-OCT-2019'
GROUP BY AP.Name
```

4. Q4: Find out how large the agricultural area of rice, corn, and soybeans affected by the eruption of Mount Agung in Bali at November 27,2017 with a radius of 20 km?

SQL Query:
```
SELECT AP.Name, SUM(F.area)
FROM Production P, AgricultureProducts AP, Time T,
Fields F, Village V, SubDistrict SD, District D
WHERE P.ProductKey = AP.ProductKey AND P.TimeKey =
T.TimeKey AND P.FieldKey = F.FieldKey AND
ST_Distance(F.fieldGeo,MountAgungGeo) < 20 AND T.Date
BETWEEN '27-SEP-2018' AND '27-OCT-2019'
GROUP BY AP.Name
```

5. Q5: Determine how much seed and fertilizer needs for rice, corn, and soybeans farming at the beginning of the first planting season this year for farmer groups in Sleman district?

SQL Query:
```
SELECT AP.Name,R.resourceName,
SUM(C.CostInUnit)FROM Cost C, AgricultureProducts AP,
Resources R, Time T, Fields F, Village V,
SubDistrict SD, District D
WHERE P.ProductKey = AP.ProductKey AND P.TimeKey =
T.TimeKey AND P.FieldKey = F.FieldKey AND
F.VillageKey = V.VillageKey AND
F.SubDistrictKey=SD.SubDistrictKey AND SD.DistrictKey
= D.DistrictKey AND D.districtName = 'Sleman" AND
T.Month = 'February' and T.Year = 2019
GROUP BY AP.Name, R.ResourceName
```

Figure 6 displays the visual report of the sample query.

Fig. 6. Visualization of query Q1 result

Table 3 shows the results of the average execution test of the query. The DW is implemented in PostgreSQL and PostGIS using Pentium Core i5 with 8GB RAM. The results are not designed to be conclusive but only suggest the expressiveness of Spatiotemporal Query.

Table 3. Query Execution Test

Query	Execution Time (s)
Q1	2.5
Q2	4
Q3	4.5
Q4	3
Q5	5

V. Conclusion and Future Works

The design and development of Agriculture Spatiotemporal Business Intelligence have been finished by integrating transactional data from SIDeKa using Open Data Integration. This system is able to answer the important questions used for strengthening the food availability and handling of food security. Integration mechanism using Web Service API makes the data warehouse more flexible and dynamic, every single update on the data source will propagate to the data warehouse instantly.

In the future, the challenge is how to extend the data warehouse with the data source in the format of the LOD Semantic Web for SIDeKa. Integration with existing vocabulary and another LOD will enhance the capability of the system with the bigger catalog and have standardization of terms and concepts of the application domain through an appeal to ontologies and vocabularies. Using this LOD as a data source the data warehouse also could be enriched with the new semantic and mechanism to provide further knowledge to allow reasoning via logical axioms in the entire process of business intelligence and data warehousing.

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