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GIS Open Sources for Mapping the Customer Lifetime Value of KR1M in Malaysia: Criteria, Tools and Platform

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ABSTRACT

Traditionally, the lifetime value of business including Kedai Rakyat 1Malaysia (KR1M) was measured by financial-based model (called as non-spatial model) since the first model was introduced in early 1930s. The roots of establishment of customer lifetime value (CLV) model is to determine how long the business can be survived that is depend on the financial success of the business. Based on current literature review, the model of CLV is dominating by non-spatial variables, as representing by the most well known model of recency, frequency and monetory model (RFM model). The main objective of the study is to compare the GIS open source for mapping the CLV of KR1M in order to understanding the sustainability of KR1M. The comparisons are based on criteria, tools and platform with regard to suitability for mapping the CLV of KR1M. The method used in this study was exploration study by testing and evaluating the performance of the three (3) GIS open sources such as Quantum GIS, PostGIS, and Cloud-Native GIS Tools. The major finding is Cloud-Native GIS is the most preferred choices for mapping the CLV of KR1M based on some reasons. In addition, this study will help the government, policy makers and researcher in understanding the sustainability of KR1M in current marketplace, accordingly to spatial based point of view.

1. Introduction

Historically, the first espoused in the 1930s, the Customer Lifetime Value (CLV) model was originally designed to assess the net present value of a customer's future spending. The father of Database Marketing that is Arthur M. Hughes introduced database approach for managing the customer relationship, formerly using financial-based instruments and model. After that, CLV is in widespread use among almost all small, medium and large firms in the marketing field in every sectors of business. There are three generic strategies for increasing CLV including (a) increase

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customer spending rate; (b) increase customer retention rate; and (c) increase customer referral rate [1]. Furthermore, the CLV research stream is aims at developing and maintaining profitable business relationships with selected profitable customers.

Continuously, the change of CLV in the marketplace as a traditional unpredictable issues to the firm, where each decade of years 1980s, 1990s and 2000s has dominated by unique major phenomenon. The CLV of shopping habits of consumers in the 1970s and 1980s were highly influenced by the brand of the product. Empirically, the percentage of consumers who claim that they tend to stick with well-known brands when purchasing products and services has dropped dramatically for all age groups, in between of 1975 and 2000. Even the percentage for individuals over 60 years old – typically among the most brand-loyal consumers – dropped 20 points in the past 25 years [2]. The study by Lipke [2] is related to Rosenfield [3] and Van Rensburg [4] where CLV in the 1980s and 1990s are stimulus by firms and then, influenced customer shopping activity in the marketplaces. Recent studies about CLV in the same area are related to work from Bhattacharyya *et al.*, [5], Joshi and Budke [6], Awaad *et al.*, [7], Haverila *et al.*, [8], Bekamiri *et al.*, [9], Hiramanek *et al.*, [10] and Marisa *et al.*, [11]. Most of researchers pointed that CLV is main standard for measures the sustainability of the business, including the KR1M and related small retailers.

2. Higlights of the Work

Theoretically, the CLV concept is extensively changing the way today's customer is managed as well as CLV as the foundation of customer profitability [12]. By understanding CLV, practically, it provides the best way to gain the competitive edge and reshaping the way the business manage with final aim to maximize their profitability and growth [13]. In advance, some researchers like Sohrabi *et al.*, [14], Graf *et al.*, [15] and Fabel *et al.*, [16] believed CLV need to be revised and re-conceptualized, as implication of new challenge that exist in the marketplace. Recently, scholars such as Johannessen *et al.*, [17], Damm et al., [18] and Ali *et al.*, [19] also premise the same way of thinking where the CLV valuation needs to consider previous and current information of customers in the marketplace. Therefore, the CLV model and approach need to be redefined and reformulated to make it more suitable, as cordially of the unsolved issues of CLV and profitability.

Managing the customer lifetime value (CLV) is the top one initiative to ensure the sustainability of firms' profitability, both short and long term of performances, as mentioned in Bhattacharyya *et al.*, [5], Joshi and Budke [6] and Awaad *et al.*, [7]. It is critical to understand and sustain the CLV as well as business profitability, where it is important to a lifetime of business survival, as mentioned in Haverila *et al.*, [8] and Bekamiri *et al.*, [9]. To maximise long-term returns of the company, customer's value must be managed so as to move in the same direction as customer profitability. Essentially, this requires information on which of customers are most profitable to firm, how to satisfy their needs, how the firm acquire and retain their profitable customers, and how firm convert less profitable customers or cease trading with them [20]. In addition, Berman *et al.*, [21] have discussed some issues on profitability which included how the business can best serve the customers while retaining fair profits; how the business stand out in a highly competitive environment where consumers have so many choices; and how the business grow up their business while retaining a core of loyal customers. Thereby, customer is a source of CLV and profitability where they have power to revolutionize their relationships to the business [22] and because of consequences of consumers intensely value-oriented, even more than in the recent past [23].

Strategically, valuing customers is a central issue of any commercial activity. The value of an individual customer is important for the detection of the most valuable ones, which deserve to be closely followed and for the detection of the less valuable ones, to which the company should pay less attention [24]. Currently, Hamit [25] stressed that customer valuation is a crucial step for the business where CLV traditionally used for it evaluation. Meanwhile, Mark [26] thereby noted the CLV is a gold standard of customer profitability that is useable to increase the business performance. By sharing the same point of view, Fabel *et al*., [22] believed that establishing relationship with customer is important to increase their revenues. This is supported by Libey [27] where he suggest that the customer profitability must be evaluated for each of the customers where the value lies in the ability to see change over time; indeed, that may be the only value as it becomes a replicable measurement of consistently improving profitability created from increasingly better decisions.

There are some issues highlighted in context of CLV and Geospatial Information System (GIS) potential uses, specifically refer to Kedai Rakyat 1Malaysia (KR1M). An important view on problems, research gaps, and prospects are identified and discussed, as followed:

2.1 Constrains of Spatial Modelling the Sustainability of KR1M

Traditionally, CLV model is mostly developed based on financial, accounting or non-spatial based instruments. In the firm-based CLV model, CLV is developed based on accounting or financial based measurement with highly consideration on items such as costs, expenses, investment, rate, and any kind of tangible values that was cited in major works of Bejou *et al*., [13], Rust *et al*., [28] and Gupta *et al*., [29]. In contrast, in the perspective of customer-based CLV model, CLV is more on customer-related behavior purchasing activity, such as recency, frequency, and monetary instruments, as described as RFM model by Libey [27]. Similarly, both of perspectives are modelled either based on mathematical or statistical modelling with finale aim to estimate the profitability customers to the business. However, all of CLV models are not applicable to visualize the CLV results in term of location, as customer located in the marketplace. Although, there are new CLV models continuously introduced and applied in the industry, as well as ICT-based model and, or even data mining or neural networks based model, similarly, those models have no capability to visualize the CLV of KR1M as different location of KR1M has different environment. In fact, most of traditional CLV models are not able to model the non-financial factor surrounding the marketplace of KR1M where it can affect the sustainability of KR1M in current and future performance.

2.2 Limitation of CLV Platform to Identified the Spatial Aspect of KR1M

There is a question on CLV about how CLV model will change according to current issues on the business marketplace, called as physical marketplaces which locate entities such as business, customer, competitors, supplier, and many more. Although various type and number of CLV models have been introduced into the market, these models are unable to receive any reflects from change in the marketplaces especially non-financial factors. This is explained by Environmental System Research Institute [30] ESRI (2002) that estimates approximately 50 percent of today's retail stores do not capture customer information as part of the business transaction. Without this kind of information, it is difficult to quantify the demographics of customers or market areas. Thus, CLV model is not perfect enough for estimating CLV because traditional CLV model cannot generate and integrate any spatial data from the geographical marketplaces into their analysis. With regard to Environmental System Research Institute [30] the business actually needs to understand that all the problems that they faced are related to geographical problems, as identified as spatial problem. It’s not practical to analyze key segments of KR1M without understanding CLV is a part of spatial issues.

KR1M will serve the same consumer segment as retailer do, but with emphasis on consumers with basic essential needs. Unlike other regular grocery shops, most of the items sold at KR1M such as rice, cooking oil, milk powder and diapers are packed with the logo of KR1M. Currently, the assortments totals almost 250 KR1M grocery items and the list will increase over time. Beside that, competition is a thorn to any business as mentioned by Berman *et al*., [21] that includes how the retailers can best serve the customers while retaining a fair profits and how the retailers stand out in a highly competitive environment where consumers have so many choices. In addition, Janiak [23] pointed out that any kind of business also confronted with such issues of reduced consumer spending that might affect the revenues. Based on the scholars as mention above, the sustainability of KR1M must be evaluated, with considers financial (non-spatial) and non-financial (spatial location) as key indicator of it measurement.

To sum up, issues of KR1M and CLV are of continuing interest to the Government and public policy makers, as well as business managers and academic researchers. Interestingly, estimating the KR1M profitable using a combination of spatial and non-spatial factors will become a new knowledge and model where it will integrate financial and non-financial factors. Thereby, factors (spatial and non-spatial) that contribute to CLV of KR1M should be studied together where both factor have potential to effect the sustainability of KR1M in current and future prospect.

3. Research Methodology

The method used in this study was exploration study by testing and evaluating the performance of the three (3) GIS open sources such as Quantum GIS, PostGIS and Cloud-Native GIS Tools. Testing and evaluation of the GIS open sources will be apply by explore, testing and evaluating the feature, capability and platform as offers by the GIS open sources.

Geographic Information Systems (GISs) have emerged as effective tools for the mapping of business. There are several types of GIS software on the market, but the most widely used are QGIS [31] and ArcGIS [32]. GISs are powerful tools for collecting, storing, retrieving, transforming, and visualizing spatial data. Their ability to analyze and visualize agricultural environments and workflows has proven to be beneficial for the agricultural sector [33]. GIS technology is becoming an essential tool for combining different sources of data, such as data acquired by drones, airborne sensors, and satellites [34]. In the field of GIS open source software experienced a boost over last few years. GRASS, gvSIG, Open JUMP GIS, Quantum GIS (QGIS), uDig GIS, SPRING are open source Desktop GIS software. Geo Majas, GeoServer, MapFish, MapServer, and Open Layers are some of the open source Software for web mapping [35].

4. Research Findings

This study explores the open-source GIS based on criteria, tools and core functionalities, include desktop GIS, web GIS, spatial databases, geospatial libraries, and cloud-native tools. In addition, it highlights the latest features, use cases, and integration strengths of these platforms, reflecting the practically used for mapping the spatial and non-spatial aspects of the KR1M.

4.1 Quantum GIS (QGIS)

Quantum GIS (QGIS) is most popular, leading GIS open sources and user friendly open source software for old and new users. It is licensed under GNU public License and also called as the flagship of Desktop GIS. Anybody can download it and use freely as it works on multi-platform of windows, Linux and Mac platforms. A new mobile version is also developed for Android. There are plenty of supports, documents and tutorials available in QGIS for users. It can accept all types of data/information in different format and projections. It can perform different types of spatial analysis such as Terrain analysis, Transport Analysis, Hydrological Analysis, Network analysis, Spatial analysis, etc [35].

QGIS continues to be the most widely adopted open-source desktop GIS and its 2025 version (i.e QGIS 3.34 and beyond) has evolved into a comprehensive spatial analysis platform supporting both raster and vector based operations, with advanced symbology, and advanced real-time sensor integration. Some of key features of QGIS are includes native support for data visualization (temporal and 3D data visualization); ight integration with PostgreSQL/PostGIS, GeoServer, and OGC services; enhanced support for machine learning plugins (e.g., Scikit-learn, TensorFlow; and QField mobile app for field data collection and offline workflows.

4.2 PostGIS

Basically, PostGIS is a spatial database extension for the PostgreSQL DBMS and identified as Spatial Engine for PostgreSQL. PostGIS provides new types to PostgreSQL geometry, geography, raster, and topogeometry and SQL/MM OGC SFSQL compliant functions for doing GIS work such as cadastral management, back-end for Web mapping services. Its mean data visualization is available for mapping the spatial objects and possible for integrates spatial with non-spatial data in one platform. The core features of PostGIS are geometric processing, geographic processing, raster processing and analysis in the database, 3D surface and volume support, topogeometry functions and topologies, geocoding and address standardization and also tools for loading data. The functionality of core features of PostGIS has extends PostgreSQL into a powerful spatial database engine. It remains the backbone for enterprise-scale spatial data infrastructure, supporting millions of transactions per day with geometry and geography types that make PostGIS is suitable for managing the huge number of business networking spatially.

Key features of PostGIS are includes etter indexing for complex geometries using GIST and BRIN hybrids; upport for 3D spatial relationships and voxel data types; integration with cloud-native architectures via Kubernetes and containerization, and uilt-in functions for trajectory analysis, topology validation, and spatial clustering. The PostGIS implementation is based on light-weight geometries and indexes optimized to reduce disk and memory footprint. Using light-weight geometries helps servers increase the amount of data migrated up from physical disk storage into RAM, improving query performance substantially.

4.3 Cloud-Native GIS Tools

Cloud-native GIS tools are Geographic Information System applications and services specifically designed to operate within a cloud computing environment. They leverage the scalability, flexibility, and accessibility of cloud infrastructure for spatial data storage, analysis, and visualization, offering advantages over traditional, server-based GIS.

Some key features of Cloud-Native GIS Tools are includes TerriaJS (for building spatial data catalogs and 3D globe apps); SpatioTemporal Asset Catalog(STAC) (a modern standard for organizing EO datasets, widely used in agriculture and disaster response); Rasdaman (Array database for large-scale time-series and climate data analytics); and Actinia (REST API for scalable geoprocessing based on GRASS GIS). These tools support containerized, serverless, and scalable deployments, enabling organizations to manage petabytes of spatial data efficiently. In addition, Cloud-Native GIS are includes Cloud-Based Architecture (virtual machines, storage, and databases offered by providers such as AWS, Azure, or Google Cloud); scalability and Elasticity (cloud-native

GIS can easily scale resources up or down); Microservices Architecture (Cloud-native GIS often employs microservices, and breaking down functionality into smaller); data accessibility and collaboration (cloud-native GIS makes it easier to share and collaborate on spatial data and analysis through web-based interfaces and APIs); automation and serverless workflows (automate tasks and leverage serverless functions to process geospatial data); support for Cloud-Native Formats (Cloud-native GIS tools increasingly support formats like GeoParquet and Cloud-Optimized GeoTIFF (COG) for efficient storage and access to spatial data).

5. Result and Discussion

Based on expert review as above, Cloud-Native GIS is the most preferred choice for mapping the customer lifetime value of KR1M based on advantages as:

- Reduced infrastructure costs: Pay-as-you-go pricing models for cloud resources can significantly lower infrastructure costs compared to maintaining on-premise servers.
- Improved scalability and performance: Cloud resources can be easily scaled to handle large datasets and complex analysis tasks.
- Enhanced collaboration and data sharing: Cloud-based platforms enable teams to collaborate in real-time on spatial data and projects.
- Faster development and deployment: Cloud-native tools often offer APIs and pre-built components that can accelerate the development and deployment of GIS applications.
- Access to advanced technologies: Cloud providers offer access to cutting-edge technologies like AI and machine learning for geospatial analysis.

For mapping the location of KR1M, location of customer and the spatial value of KR1M, Cloud-Native GIS Tools are available and possible to used are includes

- **ArcGIS Online:** A cloud-based platform from Esri that provides a wide range of GIS capabilities for professionals.
- **Felt:** A cloud-native, collaborative mapping platform built on PostGIS and PostgreSQL.
- **Google Earth Engine:** A platform for planetary-scale geospatial analysis with a vast catalog of satellite imagery and geospatial datasets.
- **CARTO:** A cloud-native platform focused on location intelligence and spatial analysis.
- **SuperMap GIS:** A cloud GIS server based on a high-performance cross-platform GIS kernel, supporting massive vector/raster data publishing and microservice integration.
- **Atlas:** A browser-based GIS platform focused on simplicity and collaboration.
- **QGIS:** While traditionally a desktop application, QGIS is increasingly being used in cloud environments and has a cloud-native plugin system.
- **Google Cloud Platform (GCP) and BigQuery:** GCP offers various services for geospatial analysis, including BigQuery for handling large datasets.
- **Spatial AI:** Tools like Flai leverage AI and cloud computing for automated point cloud classification and other advanced analysis tasks.

6. Conclusion

In conclusion, open-source GIS tools offer the flexibility, scalability, and innovation edge required for modern geospatial applications. They are not only for mapping purposes, but covers foundational to big application such as smart cities, digital twins, autonomous systems, and environmental sustainability projects. In another aspect, as industries increasingly rely on geospatial intelligence for decision-making, the open-source ecosystem offers a viable, future-proof pathway. Cloud-native

GIS refers to Geographic Information Systems designed and built to leverage the scalability, flexibility, and accessibility of cloud computing environments. It moves away from traditional on-premise GIS infrastructure by utilizing cloud services, microservices, containers, and serverless computing. This approach allows for efficient storage, analysis, and visualization of spatial data, facilitating collaboration and real-time data processing. Utilizing these platform will make the mapping process of CLV are become more advanced and sophisticated, according to the latest trend of GIS world.

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