Mapping the Customer Lifetime Value of KR1M in Malaysia: A Suitability Study of GIS Open Sources

Dr. Gs. Abdul Manaf Bohari, Dr. Cheng Wei Hin[2], Dr. Khairol Anuar Ishak[3]

[1] *School of Business Management, Universiti Utara Malaysia, Sintok, Kedah, Malaysia*
E-mail: manafdr@uum.edu.my

[2,3] *Department of Business Management, Universiti Utara Malaysia, Sintok, Kedah, Malaysia*
E-mail: cw.hin@uum.edu.my; khairol@uum.edu.my

Abstract

Traditionally, the lifetime value of business including *Kedai Rakyat 1Malaysia* (KR1M) was measured by non-spatial model since the first model was introduced in early 1930s. The fundamental of establishment of customer lifetime value (CLV) model is to determine how long the business can be survived as well as determine the sustainability of the business. Based on current literature review, the CLV method, appraoch and model is dominating by non-spatial measurement, that makes spatial measurement is out-of context. The main objective of the study is to review the suitability of GIS open source for mapping the CLV of KR1M purposely to estimate the sustainability of KR1M. The comparisons are based on feature, tools and capability/platform, specifically with regard to task for mapping the CLV in spatial environment setting. The method used in this study was exploration study by testing and evaluating the performance of the eight (8) GIS open sources such as Quantum GIS, PostGIS, GeoServer and MapServer, OpenLayers and Leaflet, GDAL/OGR, Pythonic Spatial Libraries, GeoNode and MapStore, and Cloud-Native GIS Tools. The major finding is found that Cloud-Native GIS is the most preferred choices for mapping the CLV of KR1M, with reasonable arguments. In addition, this study will help the policy makers, government agency, and researcher in visualized the sustainability of KR1M in real marketplace, accordingly to spatial perspective.

Keywords : *Kedai Rakyat 1Malaysia (KR1M); Customer Lifetime Value; GIS Open Source*

I. 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 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, compared to consumers today that are less likely to purchase a specific brand or patronize a particular company simply because the brands are well-known [2]. 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. The study by Lipke is related to [3] and Rosenfield [4] where CLV in the 1980s and 1990s are stimulus

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

by firms and then, influenced customer shopping activity in the marketplaces.

Recent study about CLV in the same area are related to work from [5], [6], [7], [8], [9], [10], and [11]. Most of researchers pointed that CLV is main standard for measures the sustainability of the business, including the KR1M and related small retailers.

II. LITERATURE REVIEW

Theoretically, the CLV concept is extensively changing the way today's customer is managed as well as CLV as the foundation of customer profitability as noted by [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 [14], [15], and [16] believed CLV need to be revised and re-conceptualized, as implication of new challenge that exist in the marketplace. Recently, scholars such as [17], [18], and [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, according to the current unpredictable marketplaces of the business, as cordially of the unsolved issues of CLV and profitability as arisen in between of the relationship of customer-business.

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 [20], [21], and [22]. 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 [23] and [24]. [25] noted that 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. In addition, [26] 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 [27] and because of consequences of consumers intensely value-oriented, even more than in the recent past [28].

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 [29]. Currently, [30] stressed that customer valuation is a crucial step for the business where CLV traditionally used for it evaluation. Meanwhile, Mark [31] 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, [32] believed that establishing relationship with customer is important to increase their revenues. This is supported by [33] 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. With regard to these scholars, business must regularly evaluate their customers with the finale aim to identify their best customers, who's potentially contributes profitable CLV to their business lifetime value.

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:

A. Limited Capability of CLV Approach

Since the CLV has been introduced to the field in the 1930s especially on marketing/retailing research, a multitude of CLV approaches have emerged, with variation in definitions, terms, and analogies. Specifically, there are two main streams of theoretical differentiable approaches for CLV, identified as CLV from a company perspective and CLV from a customer's perspective. However, both approaches have limitations on capability that been used for estimating the profitability of non-profit business such as Kedai Rakyat 1Malaysia (KR1M).

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

CLV in context of company, the CLV is assumed as central activity for the business with mainly objectives is to evaluate how attractive individual customers or customer groups are from a company's perspective, such as [34], [35], [36], and [37]. Meanwhile, CLV in context of customer has focused on value generated on a company's product or service as perceived by the customer or the fulfilment of customer goals and desires by company products and/or services, as mention in [38]. In addition, [39] state that there are too many marketing managers either fail to identify the most valuable customers or spending their marketing budget on the wrong customers. One of the problems is the CLV approach is backward looking and do not provide a future picture of customer's profitability. On contrary, [40] criticized this method, since a long life-cycle and the profitability of a customer were not necessarily related.

The existing of two major approaches actually will create the dual nature of CLV. According to [41], practically, the gaps are arising from these two approaches, and finally, generated vertical gap (internal gap) and horizontal gap (information, communication and perceived value gaps). Because of dual customer value model was developed based on a broad view of customer values, the decrease of some gaps (internal gaps) and the increase of other gaps (perceived gaps) in any model will enable companies to provide customers with the value desired by the customers.

With regard to the work as mention above, new approaches should be introduced to bridge the current gaps, as well as aiming to reduce the variations of the CLV results. In fact, the variations between these gaps cannot be standardized, or integrated into one platform until the new approach is established to the market. Critically, these gaps are expected to become more diverse in the future of prospecting the CLV, as well as profitability KR1M will be more difficult to predict.

B. Constrains of existing CLV models for 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 [40], [41], and [42]. 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 [41]. 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.

The traditional CLV model as well as financial/account types models, CRM/marketing types models, operation/decision science types models and ICT/Computer science based models consistently apply financial or accounting related instruments. For example, Customer Segment Knowledge Model by [39] has utilized financial based instruments, but does not support any analysis related to spatial location of customer. In fact, non-financial instrument such as location factor can affect the profitability of business as mentioned in some work of [40], [41], and [42], This is also supported by [43] as they noted that predicting the CLV of a customer requires several related factors to spatial location. The predicted problem is transformed to a problem of creating a mapping function having all related features as its variables. Thus, according to these scholars new technique must be introduced for modelling the CLV of KR1M by integrating the non-financial variables into it.

B. Kedai Rakyat 1Malaysia (KRIM) and CLV Issues

In Malaysia, Kedai Rakyat 1Malaysia (KRIM) is the top issues of Malaysian society that has greater contribution to the whole lifetime value of 'the Rakyat'. KR1M is a shop operating on a mini market format, which provides various basic necessities at low prices. The existence of 'Kedai Rakyat 1 Malaysia' will also act as the medium for the Government to control prices and lessens the monopolization of products which has long been dominated by the multinational manufacturers. However, KR1M will face a lot of challenge especially huge competition with other business that also offers low prices scheme. [43] noted

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

competitive advantage is a significant and has long-term benefits that retailers enjoy over its competition. Competitive advantages will lead the companies to bring themselves into the right way forward and requires retailer to scan and follow the current change of external and internal environment of business, in order to generate new knowledge to them. Similarly, [33] raised-up that competition is thorny issue where lack of differentiation among competitors and this is actually a dangerous situation for retailers. By taking these premises in a context of this study, the KR1M faces huge competition where it will involve large number of customers, competitors, products and a lot more, as explained by [38] and [43] of these, [44], cited as customer is the key factor that can influence the key performance indicator of the profitable business, includes non-profit business like KR1M.

Malaysia is a multicultural society in which several ethnic groups like Malay, Chinese, Indian, Iban, Melanau, Kadazan, and many more live together. The existing multi ethnicity in Malaysia will create unique needs and demand of food and product purchase from the hypermarket. Every ethnic has their own demand on products. This is in a line of KR1M expansion on the whole state of Malaysia. Currently, the government had already opened 85 KR1M in the peninsula, namely 25 in 2011 and 60 more in 2012 at a cost of RM40 million. Locations for the 33 KR1M have been identified as reported in Bernama (Feb 07, 2013). The issue is how KR1M can predict the behaviour of the customers on purchasing activity without understanding their basic demographic background. Therefore, demographic and customers' behaviour should be include in predict the CLV of KR1M where these data will be useful to visualize the sustainability of KR1M.

III. RESEARCH METHODOLOGY

The method used in this study was exploration study by testing and evaluating the performance of the eight (8) GIS open sources such as Quantum GIS, PostGIS, GeoServer and MapServer, OpenLayers and Leaflet, GDAL/OGR, Pythonic Spatial Libraries, GeoNode and MapStore, 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. There are five (5) panel of expertise used in this evaluation process. Process of explore, testing and evaluating the GIS open sources will take about 48 hours for each of the software. There are two major aspects concern in the exploration are aspects of suitability of GIS open source for mapping the CLV of KR1M and capability of GIS open source software for estimate the sustainability of KR1M. After that, the panel will report the finding, which mostly based on their experience about the software. In addition, ranking scale also used and marks by the expertise, as finale result of the exploration study.

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 [41] and ArcGIS [43]. 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 [44]. GIS technology is becoming an essential tool for combining different sources of data, such as data acquired by drones, airborne sensors, and satellites [45].

There are many commercial GIS software available for GIS applications such as ESRI's ArcGIS, Geomedia, MapInfo Professional, Global Mapper, manifold GIS, Small World, Bentley Map, Map viewer etc. ArcGIS is well-established commercial software in GIS industry. 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 [45]. In this study, the exploration of GIS open sources is limited to the eight (8) GIS open sources, as mentioned above.

IV. RESULT AND DISCUSSION

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.

A. 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

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

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 [41].

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).
- Tight integration with PostgreSQL/PostGIS, GeoServer, and OGC services.
- Enhanced support for machine learning plugins (e.g., Scikit-learn, TensorFlow).
- QField mobile app for field data collection and offline workflows.

B. 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

- Better indexing for complex geometries using GIST and BRIN hybrids.
- Support for 3D spatial relationships and voxel data types.
- Integration with cloud-native architectures via Kubernetes and containerization.
- Built-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.

C. GeoServer and MapServer

GeoServer and MapServer are leading open-source tools for serving geospatial data through standard web services (WMS, WFS, WCS) and its OGC-Compliant Web Services. They provide essential backend services for modern web maps and APIs. GeoServer and MapServer are both popular open-source web GIS software used for publishing maps over the internet, but they have some key differences. They both support various OGC (Open Geospatial Consortium) standards like WMS, WFS, and WCS, allowing them to be used in a variety of web mapping applications.

GeoServer, written in Java, excels in its user-friendly web-based administration interface and support for transactional WFS (Web Feature Service), allowing for editing of feature services. Data is published via standards based interfaces, such as WMS, WFS, WCS, WPS, Tile Caching and more. GeoServer provided with with a browser-based management interface and connects to multiple data sources at the back end.

Meanwhile, MapServer, written in C, is known for its speed, particularly in WMS (Web Map Service) and its configuration and scripting capabilities. MapServer is widely known as one of the fastest mapping engines in the world. It is supported by a diverse group of organizations that fund enhancements and maintenance, and is administered within OSGeo by the MapServer Project Steering Committee. MapServer is driven by a very vibrant and helpful Open Source community.

Key features of GeoServer are includes

- Support for vector tiles (MVT), COG (Cloud-Optimized GeoTIFF).

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

- Integrated styling via SLD and CSS.
- WebSocket-based real-time layer updates.
- Docker and Helm chart availability for cloud deployments.
- Performance improvements for high-demand tile rendering.
- Native support for OGC API - Features and Tiles (the RESTful successor to WFS/WMS).

GeoServer strengths are includes

- User-friendly web interface: Easier to configure and manage through a web-based interface.
- WFS-T support: Supports transactional WFS, enabling editing of spatial data on the client-side.
- Java-based: Offers flexibility and platform independence due to being Java-based.
- Cascading WMS: Can proxy remote WMS services, allowing for integration and manipulation of external map data.

MapServer has strengths on some aspects of

- Speed and efficiency: Built in C, it leverages optimized libraries for spatial data handling and is known for its performance, especially with WMS;
- Lightweight: Generally considered a lightweight solution;
- Configurable and scriptable: Highly configurable and can be controlled through various scripting languages;
- Mature project: Has been under development for a long time, with a large and active community.

D. OpenLayers and Leaflet

Basically, OpenLayers and Leaflet are both popular JavaScript libraries for creating interactive web maps. OpenLayers and Leaflet are both prominent open-source JavaScript libraries for creating interactive web maps, each offering advanced capabilities tailored to different needs. It is Web Mapping Libraries. Leaflet is known for its simplicity and ease of use, making it suitable for smaller, less complex projects. OpenLayers, on the other hand, offers more advanced geospatial functionality and is better equipped to handle larger datasets and complex projections, making it a good choice for more demanding applications.

The functionality between them for advanced use cases often depends on some aspects:

- Complexity of geospatial data and projections: OpenLayers is preferred for highly complex data and custom projection requirements.
- Need for fine-grained control and customization: OpenLayers offers more control at a lower level.
- Reliance on pre-built solutions and ease of integration: Leaflet's plugin ecosystem can accelerate development for many advanced features.
- Performance requirements for large datasets: Both handle large datasets, but OpenLayers' rendering techniques are often more suited for extremely complex or high-resolution data

For client-side web mapping, OpenLayers and Leaflet continue to dominate. These JavaScript libraries help developers build highly interactive spatial applications without proprietary SDKs.

Some key features of OpenLayers of latest version 2025 are includes

- 3D globe visualization using Cesium integration.
- Native support for GeoPackage and vector tiles.
- Real-time layer updates from MQTT and WebSocket feeds.
- In addition, Leaflet's strengths are covers lightweight performance ideal for mobile and embedded devices; Integration with D3.js and Chart.js for spatial-analytical overlays; and community plugins for routing, clustering, and geo referencing.

Leaflet has advantages on some aspects of

- Simplicity and ease of use: Leaflet is known for its intuitive API and straightforward implementation, making it easy to get started with web mapping.
- Lightweight: It has a small footprint and loads quickly, making it suitable for mobile-friendly applications.
- Extensive plugin ecosystem: Leaflet offers a wide range of plugins for added functionality.

OpenLayers has advantages on some aspects of

- Advanced geospatial functionality: OpenLayers provides a rich set of tools for handling projections, coordinate transformations, and working with various data formats.
- Support for large datasets: It's designed to handle large and complex geospatial datasets efficiently.
- Highly customizable: OpenLayers offers extensive customization options for

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

advanced GIS features and map interaction.

E. GDAL/OGR (The Universal Translator)

The Geospatial Data Abstraction Library or GDAL, is a widely used open-source software library for reading and writing raster and vector geospatial data formats. It is released under an MIT-style free software license by the Open Source Geospatial Foundation (OSGeo). GDAL/OGR also often referred to as "The Universal Translator," which is a powerful open-source library and set of command-line tools for reading and writing geospatial data in various raster and vector formats. Functionally, GDAL/OGR acts as a bridge between different data formats, enabling users to convert, process, and manipulate geospatial information.

GDAL remains a cornerstone for raster and vector data conversion. In current market of 2025, it supports over 250 formats and is optimized for high-performance ETL (Extract, Transform, Load) operations in large spatial datasets. Common features of GDAL/OGR are includes:

- Native support for AWS S3 and Azure Blob Storage.
- Enhanced streaming for massive remote sensing datasets (Sentinel, Landsat).
- Integration with Python, C++, and Rust for faster geoprocessing pipelines.

In detail, some key aspects of GDAL include:

- Data Translation and Processing: GDAL serves as a translator library, providing a unified abstract data model for both raster and vector geospatial data across numerous supported formats. This allows applications to interact with diverse data sources consistently.
- Command-Line Utilities: In addition to its library functions, GDAL includes a suite of powerful command-line utilities for common geospatial tasks like data format conversion, re-projecting, mosaicking, and general data manipulation.
- Broad Adoption: GDAL is the most widely used geospatial data access library and forms the primary data access engine for many popular Geographic Information Systems (GIS) applications and software packages, including QGIS, GRASS GIS, MapServer, and more.
- OGR Simple Features Library: A component of GDAL is the OGR Simple Features Library, which specifically handles vector geographic data, enabling the reading and writing of various standard vector formats.
- Multi-platform and Multi-language Support: GDAL is cross-platform, available on Linux/Unix, macOS, and Windows, and its core C++ library can be accessed through bindings in various programming languages, including Python, Java, and C#.

In addition, some functionality of GDAL are shows in Table 1.0.

Table 1: Functionality of GDAL

Data Abstraction	GDAL/OGR provides a consistent, abstract data model (for both raster and vector data), allowing applications to work with different formats (through a unified interface).
Format Support	It supports a vast number of formats (raster and vector), with it a versatile tool for handling diverse geospatial data.
Command-line Utilities	GDAL/OGR includes a suite of command-line utilities for tasks like data conversion, re-projection, and other geoprocessing operations.
Library for Developers	GDAL/OGR is also available as a C/C++ library, with bindings for various programming languages, that enabling developers to integrate its functionality into applications.
Open Source and Free	GDAL/OGR is released under a permissive open-source license, making it freely available for use and modification.
Widely Used	It's a foundational library in the geospatial industry, underpinning many popular GIS software packages and workflows.
Vector and Raster Support	GDAL handles both raster data (images, grids) and vector data (points, lines, polygons).
Spatial ETL	GDAL/OGR is commonly used for creating spatial ETL (Extract, Transform, Load) pipelines, allowing users to automate data processing workflows.

F. PyProj, Fiona, and Shapely (Pythonic Spatial Libraries)

Basically, python offers a rich ecosystem of libraries for working with spatial data, ranging from fundamental data handling to advanced analysis and

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

visualization. There are 3 major category are includes (a) Core Spatial Data Libraries; (b) Spatial Analysis and Visualization Libraries; and (c) Specialized Libraries, where each category as specific functions and works.

PyProj, Fiona, and Shapely are fundamental Python libraries within the geospatial ecosystem, often used in conjunction with other libraries like GeoPandas for comprehensive spatial data analysis. These Python libraries form the core of most geospatial data science workflows: In details,

- PyProj: This library provides a Python interface to the PROJ library, which is a powerful C++ library for cartographic projections and coordinate transformations. PyProj enables users to convert coordinates between different geographic reference systems (e.g., WGS84, UTM), perform geodetic calculations, and handle various aspects of spatial referencing. PyProj is used for handles projections and coordinate transformations (based on PROJ)
- Fiona: Fiona is enables reading/writing vector formats using GDAL. Fiona is designed for reading and writing vector geospatial data formats, Fiona acts as a Pythonic wrapper around the OGR Simple Features Library (part of GDAL). It simplifies the process of interacting with various file types like Shapefiles, GeoJSON, and KML, allowing users to easily load and save geospatial data in a familiar Python I/O style.
- Shapely: This library focuses on the manipulation and analysis of geometric objects in a 2D plane. Built upon the GEOS (Geometry Engine - Open Source) library, Shapely provides a rich set of functionalities for creating, transforming, and analyzing geometric shapes such as points, lines, and polygons. It allows for operations like buffering, intersections, unions, and calculating areas or lengths, all based on the principles of Simple Features Access. Shapely is provides geometric operations (e.g., intersection, buffer, union)

Some key features of Pythonic Spatial Libraries are includes

- Improved performance using Python 3.12 and multi-threading.
- Integration with Pandas and GeoPandas for spatial dataframes.
- Widely used in geospatial AI/ML model pipelines.
- Data cleansing and preprocessing for urban mobility datasets.
- Creating custom spatial analytics scripts in Jupyter notebooks.
- Automating map production workflows.

In essence, these libraries form a core toolkit for Python-based geospatial workflows: Fiona handles data input/output, Shapely provides the geometric processing capabilities, and PyProj manages coordinate system transformations.

G. GeoNode and MapStore(GeoCMS and GeoPortal Platforms)

Basically, for organizations needing collaborative geospatial content management and publishing, platforms like GeoNode and MapStore offer end-to-end web GIS solutions is the most suitable. Specifically, **GeoNode is a geospatial content management system,** a platform for the management and publication of geospatial data. It brings together mature and stable open-source software projects under a consistent and easy-to-use interface allowing non-specialized users to share data and create interactive maps. Data management tools built into GeoNode allow for integrated creation of data, metadata, and map visualizations. Each dataset in the system can be shared publicly or restricted to allow access to only specific users. Social features like user profiles and commenting and rating systems allow for the development of communities around each platform to facilitate the use, management, and quality control of the data the GeoNode instance contains.

Some key features of GeoNode are includes:

- Drag-and-drop web map creation.
- Role-based access control for layers and users.
- OGC-compliant service publishing with analytics dashboards.
- In addition, mapStore advantages are includes reactJS-based modular interface; thematic layer styling and spatial querying out of the box, and Integration with CKAN for open data portals.

There are 3 major core features of GeoNode:

- Special data recovery: includes powerful spatial search engine, federated OGC services and metadata catalogue.
- Import and Manage: Publish raster, vector, and tabular data; manage metadata and

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

associated documents; securely or publicly share data and versioned geospatial data editor.

- Interactive Mapping: GeoExplorer GIS client, graphical style editor, create multi-layer interactive maps, and share and embed maps in web pages.

MapStore is highly modular Open Source WebGIS framework developed by GeoSolutions to create, manage and securely share maps and mashups. This simple and intuitive framework is able to mix map contents provided by Google Maps, OpenStreetMap, other servers compliant to OGC standards (such as WFS, CSW, WMC, WMS, WMTS and TMS). In fact, MapStore is used to find, view and query published geospatial data and to integrate multiple remote sources into a single map; the result is an high quality and user friendly framework that allows different kind of use cases by harmonizing remote data with smart and advanced functionalities (like chart widgets, dashboards, timelines and others). MapStore resources are related to Maps, Dashboards and Stories; and its possiable to create innovative and fascinating Application Context where users can save, manage and share its own resources by also managing access permissions to other groups of users.

As a standard geoportal product, it is a web-based product that allows providing a powerful and interactive geospatial WebGIS, it provides a direct and real-time access to geospatial data warehouses and it supports the most common standards formats available for geospatial data. In addition, MapStore also provides advanced spatial analysis capabilities that can be used to build WebGIS solutions through a powerful, dynamic and open geospatial application. Since MapStore is also a framework, you can use it to build your own WebGIS applications by using its plugins and modules.

H. 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.
- STAC (SpatioTemporal Asset Catalog): 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.
- 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.

Some key characteristics of Cloud-Native GIS are includes

- Cloud-Based Architecture: Instead of relying on local servers, these tools utilize cloud resources like 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 based on demand, handling large datasets and processing needs efficiently.
- Microservices Architecture:Cloud-native GIS often employs microservices, breaking down functionality into smaller, independent services that can be deployed and scaled individually.
- 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: They can automate tasks and leverage serverless functions to process geospatial data without direct management of compute resources.
- 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.

Based on 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.

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

- 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.

The advantages of Cloud-Native GIS for mapping the CLV of KR1M are possible in aspects of

- Scalability: Cloud-native GIS can easily scale resources up or down based on demand, handling large datasets and complex analyses efficiently.
- Accessibility: Geospatial data and applications are accessible from anywhere with an internet connection, facilitating collaboration and remote work.
- Flexibility: Cloud-native GIS platforms offer a wide range of tools and services that can be customized and adapted to specific project needs.
- Integration: Cloud-native GIS seamlessly integrates with other cloud services and data sources, streamlining workflows and enhancing data analysis.

Table 2.0 shows the overall result of the study. On the side of suitability of the GIS open sources for mapping the CLV, most of panels agreed that all software suitable for mapping purposes, with 5 over 5 (5/5) expertises agreed on Quantum GIS; 3/5 (Post GIS); 3/5 (GeoServer and MapServer); 4/5 (OpenLayers and Leaflet); 3/5 (GDL/OGR); 3/5 (Pythonic Spatial Libraries); 4/5 (GeoNode and MapStore) and 5/5 (Cloud-Native GIS Tools).

Table 2.0: Overall results of the Study.

GIS Software	Suitability for mapping CLV	Capability for estimate the sustainability
Quantum GIS	5/5	4/5
PostGIS	3/5	3/5
GeoServer and MapServer	3/5	3/5
OpenLayers and Leaflet	4/5	3/5
GDAL/OGR	3/5	3/5
Pythonic Spatial Libraries	3/5	3/5
GeoNode and MapStore	4/5	4/5
Cloud-Native GIS Tools	5/5	5/5

On the side of capability for estimate the sustainability of KR1M, most of panels agreed that all software suitable for mapping purposes, with 4 over 5 (5/5) expertises agreed on Quantum GIS; 3/5 (Post GIS); 3/5 (GeoServer and MapServer); 3/5 (OpenLayers and Leaflet); 3/5 (GDL/OGR); 3/5 (Pythonic Spatial Libraries); 4/5 (GeoNode and MapStore) and 5/5 (Cloud-Native GIS Tools).

In term of ranking scale, Table 3.0 shows the result and revealed that Cloud-Native GIS Tools is the most preferred choices for mapping the CLV

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

and estimate the sustainability of KR1M. The Cloud-Native GIS Tools ranks as number 1 from all panel (expertise) in the study.

Table 3.0: Overall raking score bt the expertise.

GIS Software	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5
Quantum GIS	2	2	3	2	2
PostGIS	5	6	6	8	5
GeoServer and MapServer	6	5	5	6	6
OpenLayers and Leaflet	4	4	4	5	4
GDAL/OGR	7	8	7	4	7
Pythonic Spatial Libraries	8	7	8	7	8
GeoNode and MapStore	3	3	2	3	3
Cloud-Native GIS Tools	1	1	1	1	1

V. CONCLUSION

Overall, 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. The shift from tool usage to stack orchestration, where tools like QGIS, PostGIS, GeoServer, and OpenLayers work seamlessly together, defines the new era of interoperable and composable geospatial solutions.

In conclusion, 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.

ACKNOWLEDGMENT

We hereby acknowledge the Ministry of Higher Education, Malaysia for support and funding this research project through the FRGS Research Grant. (S/O code: 13031)

REFERENCES

[1] Lucas, A., (2009). Improve your business focus to survive a downturn. In. Carrie Yu, Susan Eggleton, Denis Smith, & Esther Mak (2009). *Retail and Consumer Worlds.* Hong Kong: PriceWaterHouseCooper.

[2] Lipke, D., (2000). Pledge of allegiance. *American Demographics*, Nov. 2000, pp. 40-41.

[3] Rosenfield, J.R (2002). *Customer relationship management: A brief history, and a big mystery*. New York: Rosenfield & Associates.

[4] Rensburg, D.J. (2012). Value: A practitioner's lens. *Industrial Marketing Management*. January 2012.

[5] Bhattacharyya, S., & Sarma, M. K. (2025). Understanding the Impact of Customer Demographics on the Lifetime Value of Small Business Customers. *SEDME (Small Enterprises Development, Management & Extension Journal)*, *52*(1), pp. 80-96.

[6] Budke A. (2024). A study on consumer buying behavior patterns of hospitality industry in India. *Rabindra Bharati Patrika*, XXVI(7), pp. 145-152.

[7] Awaad S. A., Kortam W., and Ayad N. (2024). Examining the impact of price sensitivity on customer lifetime value: Empirical analysis. *Cogent Business and Management*, 11(1).

[8] Haverila M., Haverila K. C., and Twyford J. C. (2023). The influence of marital status on customer-centric measures in the context of a ski resort using the importance of performance map analysis (IPMA) framework. *European Journal of Management*, 28(1), pp. 49–68.

[9] Machado, M.D and Ramos, P.H.B., (2023). Consumerbuyingbehavior:

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

IPMA–the technique that deepens the analysis and suggests management strategies. *RAUSP Manag.J.* (58 (4), pp. 363-369.

[10] Bekamiri H., Mehraeen M., Pooya A., and Sharif H. (2020). A stochastic approach for valuing customers in banking industry: A case study. *Industrial Engineering and Management Systems*, 19(4), pp. 744–757.

[11] Hiramanek K., Thorpe J., and Chaudhari B. (2020, December 10). Enhancing customer lifetime value (CLV) through connected data. *Datamatics*. https://www.datamatics.com/

[12] Marisa F., Ahmad S.S.S., Fachrudin Z.I.M.Y., and Aziz T.M.A. (2019). Segmentation model of customer lifetime value in small and medium enterprise using K-Means clustering and LFRM model. *International Journal of Integrated Engineering*, 11(3), pp. 169–180.

[13] Epstein, M.J., Friedl., M. and Yuthas, K. (2008). Managing customer profitability: Determine which customers are most valuable to your organizaton. *Journal of Accountancy (Business and Industry).* Harvard Business School: December, 2008.

[14] Bejou, D., Keiningham, T.L., and Aksoy, L. (2007). *Customer lifetime value: Reshaping the way we manage to maximize profits.* New York: The Haworth Press, Inc.

[15] Babak, S., and Amir, K. (2007). Customer Lifetime Value (CLV) Measurement Based on RFM Model. *Iranian Accounting & Auditing Review,* 14(47), pp 7- 20.

[16] Graf, A. and Maas, P. (2008). Customer value from a customer perspective: A comprehensive review. *Journal of Financial Business*, 58, pp. 1-20.

[17] Fader, P. (2009). Understanding customer lifetime value: Conceptual overview and implementation in excel. *Pre-Conference Workshops. Forecating Summit 2009*. Hilton in the Walt Disney World Resort, Orlando, Florida. Febuary 23-25 2009. Retrived on March 30, 2009 from http://www.forecasting-summit.com/pre

[18] Johannessen, J.A., and Olsen, B. (2010). The future of value creation and innovations: Aspects of a theory of value creation and innovation in a global knowledge economy. *International Journal of Information Management,* 30, pp. 502–511.

[19] Damm, R., and Monroy, C.R. (2011). A review of the customer lifetime value as a customer profitability measure in the context of customer relationship management. *Intangible Capital*, 7(2), pp. 261-279.

[20] Fan J and Dong L (2021) A Study on Improving Customer Value Based on the Effect of Word of Mouth. *Front. Psychol.* 12(3), pp. 628-665.

[21] Kvíčala, D., Králová, M. and Suchánek, P. The impact of online purchase behaviour on customer lifetime value. *J Market Anal* (2024). https://doi.org/10.1057/s41270-024-00328-9

[22] Bansude, S., and Vispute, J. (2022). A study on consumer buying pattern on retail stores: A literature review. *International Journal of Health Sciences,* 6(S2), pp. 8872–8882. https://doi.org/10.53730/ijhs.v6nS2.7322

[23] Cakici, A. C., and Tekeli, S. (2022). The mediating effect of consumers' price level perception and emotions towards supermarkets. *European Journal of Management and Business Economics*, 31(1), pp. 57–76.

[24] Lou, X.; Chi, T.; Janke, J.; and Desch, G. (2022) How Do Perceived Value and Risk Affect Purchase Intention toward Second-Hand Luxury Goods? An Empirical Study of U.S. Consumers. *Sustainability*. 14, (1), pp. 17-30. https://doi.org/10.3390/su141811730

[25] Chi, T.; and Kilduff, P.P. (2011). Understanding consumer perceived value of casual sportswear: An empirical study. *J. Retail. Consum. Serv.,* 18, pp. 422–429.

[26] Eileen, R. (2008). *Corporate value creation: Customer value 2008 report.* London: CIMA Centre of Excellence.

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

[27] Berman, B. & Evans, J.R., (2007). *Retail management: A strategic approach.* New Jersey: Pearson Prentice Hall.

[28] Fabel, M., Sonnenschein, M., Sester, A. and Golestan, L. (2008). *Customer energy: The empowered consumer is revolutionizing customer relationships.* Chicago: A.T. Kearney Inc. (Marketing and Communications).

[29] Janiak, S. (2009). *The age of transformation: A retail outlook for 2009 and beyond.* New York: Deloitte Touche Tohmatsu.

[30] Glady, N., Baesens, B., and Croux, C. (2009). A modified pareto/NBD approach for predicting customer lifetime value. *Expert Systems with Applications,* 36, pp. 2062–2071.

[31] Hamit, H. (2011). *Customer valuation is a crucial step for businesses.* Stamford: Peppers and Rogers Group.

[32] Mark, P. (2011). *Use Lifetime Customer Value to grow your business with no excuses marketing.* Eden Prairie: M. Squared Group.

[33] Zeithaml, V.A. (1988) Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. J. Mark., 52, pp. 2–22.

[34] Libey, Donald R. (1998). *Libey on RFM value*. New Jersey: Libey Incorporated

[35] Rust, R.T., Zeithaml, V.A., and Lemon, K.N., (2000). *Driving customer equity: How customer lifetime value is reshaping corporate strategy.* New York: The Free Press.

[36] Gupta, S. and Lehmann, D.R. (2006). Customer lifetime value and firm valuation. *Journal of Relationship Marketing,* 5(2/3), pp. 87-110.

[37] Medeiros, J.F.; Ribeiro, J.L.D.; and Cortimiglia, M.N. (2016) Influence of perceived value on purchasing decisions of green products in Brazil. *J. Clean. Prod*., 110, pp. 158–169

[38] Yang, Z.; and Peterson, R.T. (2004) Customer perceived value, satisfaction, and loyalty: The role of switching costs. *Psychol. Mark.,* 21, pp. 799–822.

[39] Environmental System Research Institute (ESRI) (2007). *GIS for retail business.* GIS Best Practice (Febuary 2007). California: ESRI.

[40] Berman, B. and Evans, J.R., (2007). *Retail management: A strategic approach.* New Jersey: Pearson Prentice Hall.

[41] Wiedmann, K.P.; Hennigs, N.; and Siebels, (2009) A. Value-based segmentation of luxury consumption behavior. *Psychol. Mark.,* 26, pp. 625–651

[42] Sebastianelli, A., Del Rosso, M.P., and Ullo, S.L. (2021). Automatic dataset builder for Machine Learning applications to satellite imagery. *SoftwareX*, *15*, pp. 10-17.

[43] Michelon, G.K., Bazzi, C.L., Upadhyaya, S., de Souza, E.G., Magalhães, P.S.G., Borges, L.F., Schenatto, K., Sobjak, R., Gavioli, A., and Betzek, N.M. (2019). Software AgDataBox-Map to precision agriculture management. *SoftwareX*, *10*, pp. 10-20.

[44] Sandhya (2020). Exploring opportunities with open source GIS. *International Journal of Engineering Research & Technology (IJERT),* 9(5), pp. 731-736.

[45] Park, M.J.; and Sohn, S.H. (2015). The effect of consumer benefit and risk perception on secondhand baby products purchasing intention and the moderating effect of consumption values and social norms. *Consum. Policy Educ. Rev.*, 11, pp. 101–122

AUTHOR'S INFORMATION

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication

First Author: Dr. Gs. Abdul Manaf Bohari 	School of Business Management, College of Business, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia E-mail: manafdr@uum.edu.my
Second Author: Dr. Cheng Wei Hin Second Author-Photo	Department of Business Management, College of Business, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia E-mail: c.w.hin@uum.edu.my
Third Author: Dr. Khairol Anuar 	Department of Business Management, College of Business, Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia E-mail: khairol@uum.edu.my

Received: 10 September 2025
Revised:29 September 2025
Accepted: 30 September 2025
Publisher: ICBE Publication