

Exploring Customer Data Using Spatio-Temporal Analysis: Case Study of Fixed Broadband Provider

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Abstract: Spatio-temporal analysis refers to the analytical technique of geographical data based on the spatial and temporal distribution of geographical objects. In business practices, implementation of spatio-temporal analysis has opportunities in providing support for strategic decision making process in resource and asset management, investment planning, customer relationship management, and marketing strategy development. Capturing the opportunities to provide support for company decision making process and strategy development, this research was conducted using spatio-temporal analysis in one of biggest fixed broadband provider in Indonesia which offers Gigabit Passive Optical Network (GPON) configuration. In this study, the analysis was conducted on the overall customer dataset and divided dataset of customers which differed based on type of customer and location environment characteristics by exploring spatially the patterns, temporal trends, and emerging hot spots of customer distribution through fishnet grid and space time cube created from GIS-based dataset of customer order. The results obtained from this study provide an overview of customer area mapping in the form of thematic map.

Keywords: Spatio-temporal analysis; geographic information system; fishnet grid; space time cube; customer area mapping.

1. Introduction

Spatio-temporal analysis refers to the analytical technique of geographical data based on the spatial and temporal distribution of geographical objects. It is a set of techniques that can be used in processing of geographic information system data which complemented with temporal attribute. It has a role in solving common problems because the observations in geographical space have dependent properties, geographically close observations tend to be more similar than those far apart [1].

Spatio-temporal analysis processes spatio-temporal data which consists of three main components, namely space (where), time (when), and object (what) [2]. Each component consists of specific elements that may have multiple attributes and are interlinked. Visualization and exploration of spatio-temporal data pattern can be done using fishnet grid and space time cube as data representation [3, 4]. Spatio-temporal data aggregated in the form of space time cube can be analyzed to identify trends and visualize changes in spatial patterns over time [5].

As time goes by, the application of spatio-temporal analysis supported by spatial technology, such as geographic information system (GIS), global positioning system (GPS), and remote sensing, emerges in various fields. Many organizations have collected large amounts of

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spatially and temporally referenced data for various purposes, such as scientific investigation, environmental impact assessment, urban planning, archaeology, humanities and social science study, crime and incident mapping, and epidemiology. In business practices, implementation of analysis from spatio-temporal data has opportunities in providing support for strategic decision making process in resource and asset management, investment planning, customer relationship management, and marketing strategy development [6].

Fixed broadband provider is one of business line unit in telecommunication industry that provides internet access through network of fixed line. Fixed broadband providers face the challenges that require them to set strategies in many aspects in order to streamline their operations and maximize their profit so that they can survive in an increasingly competitive market. In customer relationship management aspect, fixed broadband providers need to manage company's interaction with current and potential customers by exploring analysis of customer data to improve business relationships with customers, specifically focusing on customer retention and ultimately driving sales growth. In the marketing aspect, the company needs to develop an effective marketing strategy to maximize the profit potential built from the increasing trend of internet users both globally and locally [7, 8], in which the developed marketing strategy to penetrate the market needs to consider the customer's characteristics and location for efficient operations. In asset and resource management aspect, the company needs to consider the networks allocation to customers which scattered in the wide operational area. In aspect of decision-making related to the infrastructure investment planning on network infrastructure development, rejuvenation and maintenance, the company needs to set the priority of action and location considering the big investment value needed to offer service stability and support the growth of network usage and number of potential customers, especially in the region with high density.

Capturing the opportunities to provide support for company decision making process and strategy development, this research was conducted using spatio-temporal analysis in one of biggest fixed broadband provider in Indonesia which offers Gigabit Passive Optical Network (GPON) configuration. In this study, the analysis was conducted on the overall customer dataset and divided customer datasets which grouped based on type of customer and location environment characteristics by exploring spatially the patterns, temporal trends, and emerging hot spots of customer distribution through GIS-based dataset of customer order.

This paper is an extension of previous work originally presented in IEEE 8th International Conference on Awareness Science and Technology [9]. Section 2 of this paper briefly dwells on research methods, section 3 presents the results and discussion, and section 4 concludes the paper.

2. Research Methods

This research was conducted using spatio-temporal analysis on customers of fixed broadband provider with passive optical network (PON) configuration service in Indonesia which acquired within range of 1 year from April 2016 to March 2017. The data used in this study is data derived from GIS-based customer database in East Jakarta operational area which amounted to 34,970 customer records data. Each record of customer includes customer id, customer name, order date, order status, and customer location in the form of address and coordinates of longitude and latitude captured using global positioning system (GPS). The GIS-based customer data of fixed broadband provider went through two phases of data preprocessing and data processing.

2.1 Data Preprocessing

Data preprocessing phase was conducted so that the database was ready to be used for further processing phase. In this phase, data cleansing, data selection, and data categorization were conducted.

2.1.1 Data Cleansing

Data cleansing was conducted by removing 4,867 data duplication of customer records, leaving 30,103 customer data for next data preprocessing step.

2.1.2 Data Selection

Data selection was conducted by selecting customer data which coordinates located in East Jakarta operational area. Two types of customer data were omitted from customer dataset. They were customer located outside of research area boundaries and customer located inside of research area boundaries with incorrect coordinates. This step resulted in selected database containing 28,423 GIS-based customer records.

2.1.3 Data Categorization

In this step, customer dataset was divided into 4 categories based on type of customer and location environment. The mentioned four categories were (1) customers located in urban village, (2) customers located in horizontal housing complex, (3) customers located in vertical housing complex, and (4) customers located in public, institutional, and commercial buildings. Category 1, 2, and 3 were dedicated for customers in types of settlement environment or residential area, while category 4 was dedicated for customers in form of public facility, institutions, and building with commercial purpose. Category 1 was dedicated for customer in kampung or urban village environment. Category 2 was dedicated for horizontal housing complex environment, such as real estate, cluster, or other horizontal housing complex developed by private parties and government. Category 3 was dedicated for customer in vertical housing complex environment including apartment, flat, and condominium. Based on data categorization results, there are 17,328 customers in urban village, 8,914 customers in horizontal housing complex, 123 customers in vertical housing complex, and 2,058 customers in public, institutional, and commercial buildings. The GIS-based customer data resulted from data preprocessing phase were visualized using ArcGIS software version 10.5, ESRI platform of geographic information system with capability of analyzing and visualizing spatial and non-spatial data. Figure 1 shows the visualization of customers coordinates position based on their categories.

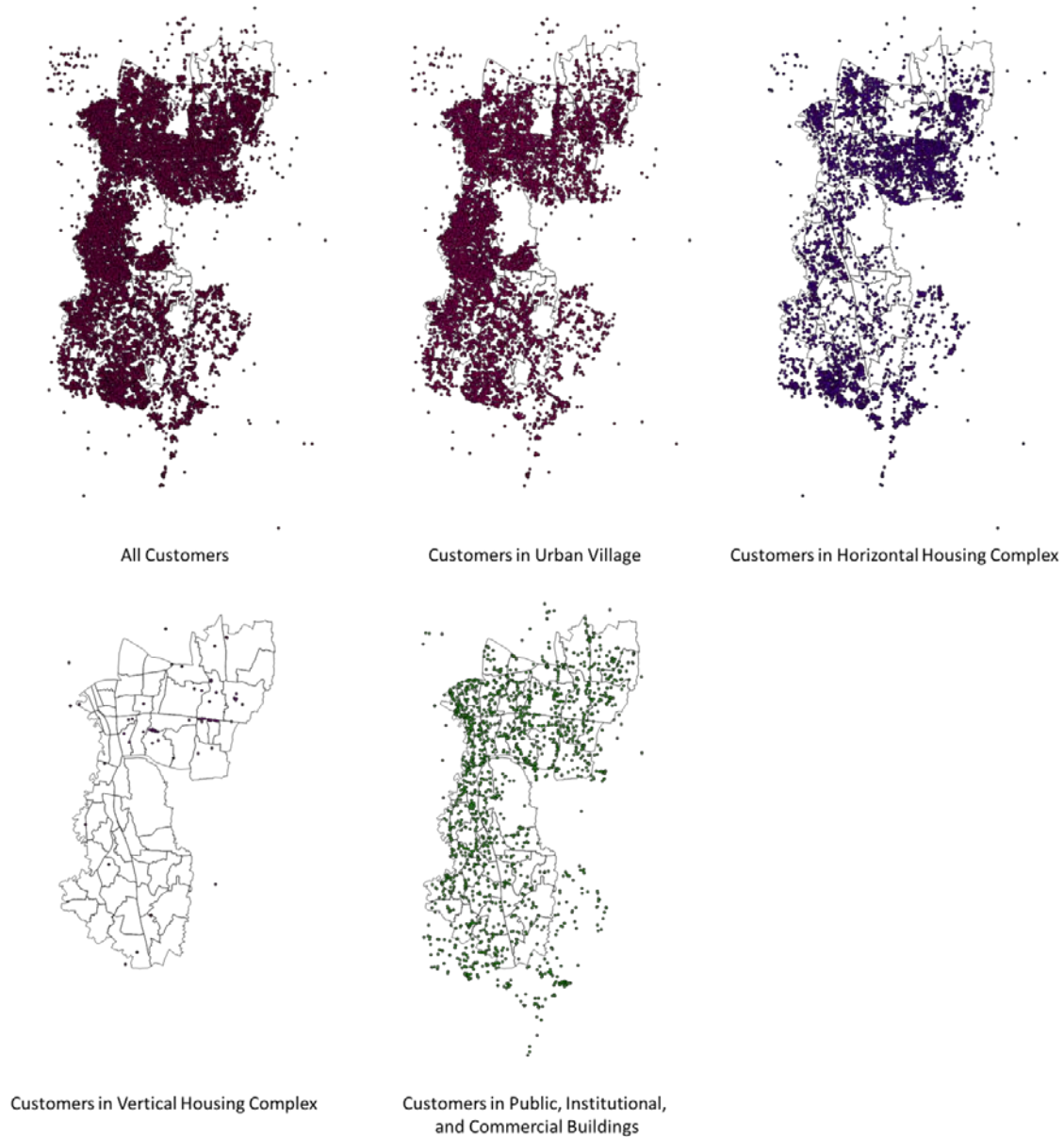


Figure 1. Customer coordinates visualization.

2.2 Data Processing

In this research, visualization and exploration of spatio-temporal data points from fixed broad customers were done through data aggregation using fishnet grid and space time cube as data representation. The fishnet grid represents the cumulative count of customers in all temporal aspect for each location grid, while the space time cube represents the cumulative count of customers in each temporal interval and each distance interval. Spatio-temporal data aggregated in the form of fishnet grid were further analyzed to identify hot spots and cold spots using Getis-Ord test. Meanwhile, spatio-temporal data aggregated into space time cube were analyzed to identify temporal trends using Mann-Kendall test and identify emerging hot spots by looking at the changes in spatial patterns over time using the combination of Getis-Ord test and Mann-Kendall test. The performed data processing only included locations with data, location which consists of at least 1 data in 1 time interval. The data processing is conducted using ArcGIS.

2.2.1 Data Aggregation

Data aggregation step was important to be conducted in study to summarize the spatio-temporal dot-shaped set of GIS-based customer data. In this step, customer data points were aggregated in fishnet grid and space time cube as seen in Figure 2. Fishnet grid summarizes spatial data points by incorporating it into square polygons, while space time cube summarizes a spatio-temporal dot-shaped set of data into a set of space time bin in netCDF data structure. The calculated value on each grid in fishnet grid reflects the number of points that occur at the corresponding location, while the calculated value on each bin reflects the number of points that occur at the corresponding location within the associated time interval.

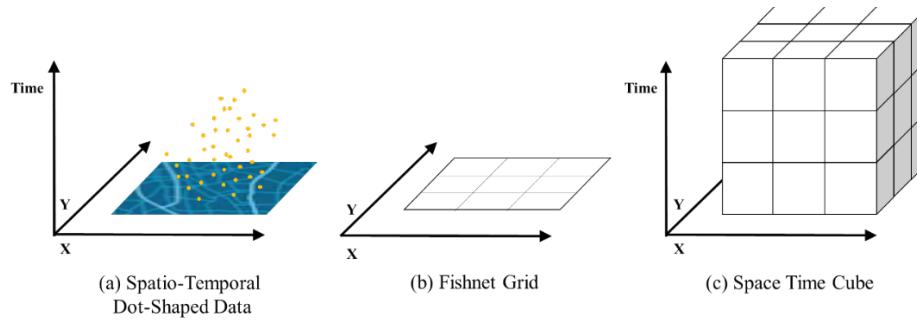


Figure 2. Data aggregation visualization.

The difference of fishnet grid and space time cube lies in the data structure as seen in Figure 3. The structure of fishnet grid has rows and columns, while space time cube structure consists of rows, columns, and time intervals. Number of location grids formed was the results of multiplication between number of rows and columns, while number of bins formed in space time cube was multiplication result among the number of rows, columns, and the time interval. Rows and columns determine spatial range, whereas the time interval determines temporal range of the space time cube. A set of associated bins in the same location grid combines to form a time series, whereas a set of associated bins in the same time interval combines into a time slice.

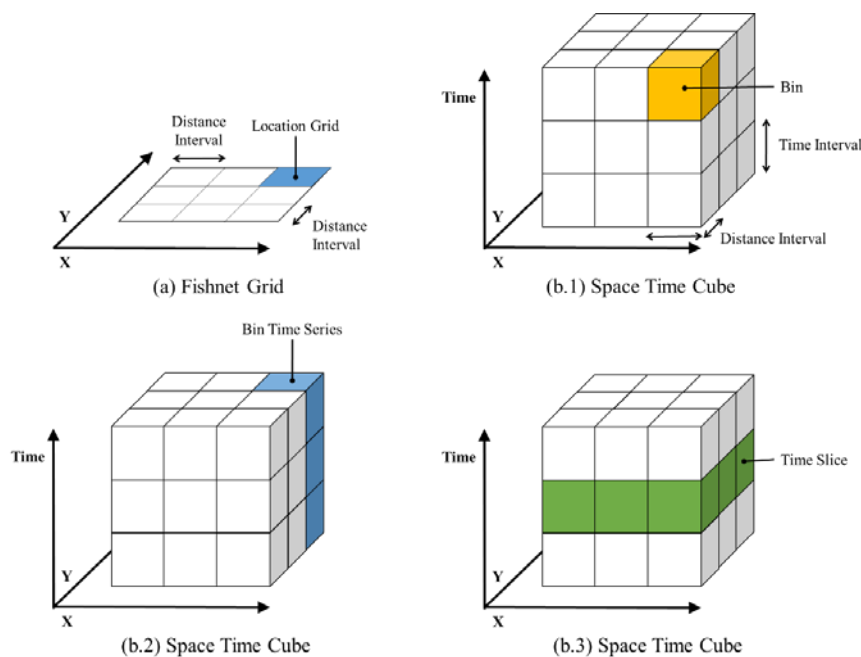


Figure 3. Data structure of fishnet grid and space time cube.

In the fishnet grid and space time cube formation, the distance interval value was determined through the same process. It was determined by the largest value between (1) the maximum range value of either longitude or latitude divided by 100 and (2) the calculated value using an algorithm based on input data spatial distribution, such as Average Nearest Neighbor (ANN) and Median Nearest Neighbor (MNN).

In the formation process of space time cube, number and width of time intervals were determined based on two algorithms of histogram bin size selection, Shimazaki and Shinomoto algorithm [10] and Rice rule [11]. The number of time intervals used in this research was the minimum value generated from both algorithms that was greater than 10.

In the first algorithm of histogram bin size selection which developed by Shimazaki and Shinomoto [10], observation period T was divided into N time interval bins of Δ time interval width. Cost function $C_n(\Delta)$ in equation (3) was computed for each possible interval width Δ . The optimal time interval width Δ^* was obtained by minimizing the cost function $C_n(\Delta)$.

$$N = \frac{T}{\Delta} \quad (1)$$

$$\Delta^* = \arg \min_{\Delta} C_n(\Delta) \quad (2)$$

$$C_n(\Delta) = \frac{2\bar{k} - v}{(n\Delta)^2} \quad (3)$$

$$\bar{k} = \frac{1}{N} \sum_{i=1}^N k_i \quad (4)$$

$$v = \frac{1}{N} \sum_{i=1}^N (k_i - \bar{k})^2 \quad (5)$$

Where k_i is number of data points accumulated from all n sequences that enter the i^{th} bin, \bar{k} is mean of the number of data points in bins, and v is variance of the number of data points in bins.

In the second algorithm, bin size or time interval width Δ^* was calculated by dividing observation period T by number of bins N . Number of bins N was defined using Rice rule [11] in equation (6) where n is number of data points.

$$N = \lceil 2^3 \sqrt{n} \rceil \quad (6)$$

$$\Delta^* = \left\lceil \frac{T}{N} \right\rceil \quad (7)$$

The data aggregation was done using time step alignment based on time intervals. As time step alignment can be done based on the last occurrence, first occurrence, or specified reference time, this research was conducted using time step alignment based on last occurrence.

2.2.2 Getis-Ord Test

Getis-Ord test is a method used to analyze hot spots in adjacent features context [12, 13]. The features may refer to location grids and space-time bins. Getis-Ord G_i^* statistic value can be calculated using equation (8) for each feature in dataset.

$$G_i^* = \frac{\sum_{j=1}^n w_{ij} x_j - \bar{X} \sum_{j=1}^n w_{ij}}{S \sqrt{\frac{n \sum_{j=1}^n w_{ij}^2 - (\sum_{j=1}^n w_{ij})^2}{n-1}}} \quad (8)$$

Where x_j is feature j attribute value (number of data points in feature j), w_{ij} is spatial weight between feature i and j , n is number of features, and \bar{X} and S are values obtained through equation (9) and equation (10). In this research, spatial weight w_{ij} was based on fixed distance band conceptualization of spatial relationship, in which neighbors within the specified distance are weighted equally and features outside the specified distance are weighted zero.

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \quad (9)$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (10)$$

The obtained G_i^* value returned for each feature in the dataset is a z-score. For statistically significant positive z-scores, the greater the z-score means the more intense the hot spot or the clustering of high values. On the other hand, for statistically significant negative z-scores, the smaller the z-score means the more intense the cold spot or the clustering of low values.

2.2.3 Mann-Kendall Test

Mann-Kendall test was used to explore data trend in time series [14, 15]. It is a nonparametric test for observation values against event sequence. Its advantage lies upon data distribution assumption free as it is unaffected by data distribution form compared to other parametric trend test such as regression coefficient test which has normally distributed data assumption [16, 17].

The statistical test S for time series, $\{x_t: t = 1, 2, \dots, n\}$, is expressed in equation (11) where x_i and x_j are number of data points in bin i and j in time series sequence.

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^n a_{ij} \quad (11)$$

$$a_{ij} = \text{sign}(x_j - x_i) = \begin{cases} 1 & x_j > x_i \\ 0 & x_j = x_i \\ -1 & x_j < x_i \end{cases} \quad (12)$$

By assuming the independent and identically distributed data, the mean and variance of S can be calculated using equation (12) and equation (13), where n is number of bins observed, m is number of tied groups, and t_p is number of bins in the p^{th} tied group.

$$E(S) = 0 \quad (13)$$

$$V(S) = \{n(n-1)(2n+5) - \sum_{p=1}^m t_p(t_p-1)(2t_p+5)\}/18 \quad (14)$$

$$Z = \begin{cases} \frac{S-1}{\sqrt{V(S)}} & S > 0 \\ 0 & S = 0 \\ \frac{S+1}{\sqrt{V(S)}} & S < 0 \end{cases} \quad (15)$$

The trend significance was tested through z -test (15), where the obtained p -value which is smaller than the confidence level indicates a significant trend. The sign (S) associated with the z -score determines the increasing or decreasing trend, in which positive z -score indicates increasing trend and negative z -score indicates decreasing trend.

2.2.4 Emerging Hotspots Analysis

Emerging hot spot analysis was conducted to identify trends of spatial patterns in dataset [18]. The conceptualization of spatial relationship parameters, such as neighborhood distance interval and neighborhood time step interval, were used to calculate the Getis-Ord G_i^* value for each bin in the space time cube. In each bin time series, hot and cold spot trends were analyzed using the Mann-Kendall test. Emerging hot spot analysis was done by clustering each location into 17 pattern categories based on the the Getis-Ord G_i^* resultant z -score and p -value for each bin and Mann-Kendall resultant z -score and p -value for each location with data. The categories are new hot spots, consecutive hot spots, intensifying hot spots, persistent hot spots, diminishing hot spots, sporadic hot spots, oscillating hot spots, historical hot spots, new cold spots, consecutive cold spots, intensifying cold spots, persistent cold spots, diminishing cold spots, sporadic cold spots, oscillating cold spots, historical cold spots, and no identified pattern.

3. Results and discussion

The results of data processing created fishnet grid and space time cube which represented the spatio-temporal dot-shaped data of customer orders. The data representations were processed further to identify hot spots and cold spots using Getis-Ord G_i^* test, identify temporal trends using Mann-Kendall test, and identify emerging hot spots by looking at the changes in spatial patterns over time using the combination of Getis-Ord G_i^* test and Mann-Kendall test.

Based on the data processing results using Getis-Ord G_i^* test on the fishnet grid locations which represents the cumulative count of customers in all temporal aspect for each location grid, the thematic map of customer hot spots and cold spots area was obtained as seen in Figure 4. The location grids in thematic map was differed by color in which the red parts illustrate the hot spots area, the yellow parts illustrate the not significant area, and the blue parts illustrate the cold spots area. The redder the red parts and the bluer the blue parts mean the higher the confidence value.

From the thematic map in Figure 4, it can be seen that customer area tends to gather to form clustered area of customers. The cluster of hot spots area mostly occurs on the western and northern area of the study region as it is located on the urban centers, while the cluster of cold spots mostly occurs on the southeastern area of study region as it is located on sub-urban area. The hot spots clustered in northwestern area are mainly formed by customers in urban village which has characteristic of high density residential area near city center with high need of internet access, while the hot spots clustered in northeastern area are mainly formed by customers in horizontal housing complex which consists of society with mid-high income. The relatively smaller cluster of all customer hot spots region in the southern area is mainly formed by mid-high class society lived in horizontal housing complex located in sub-urban area.

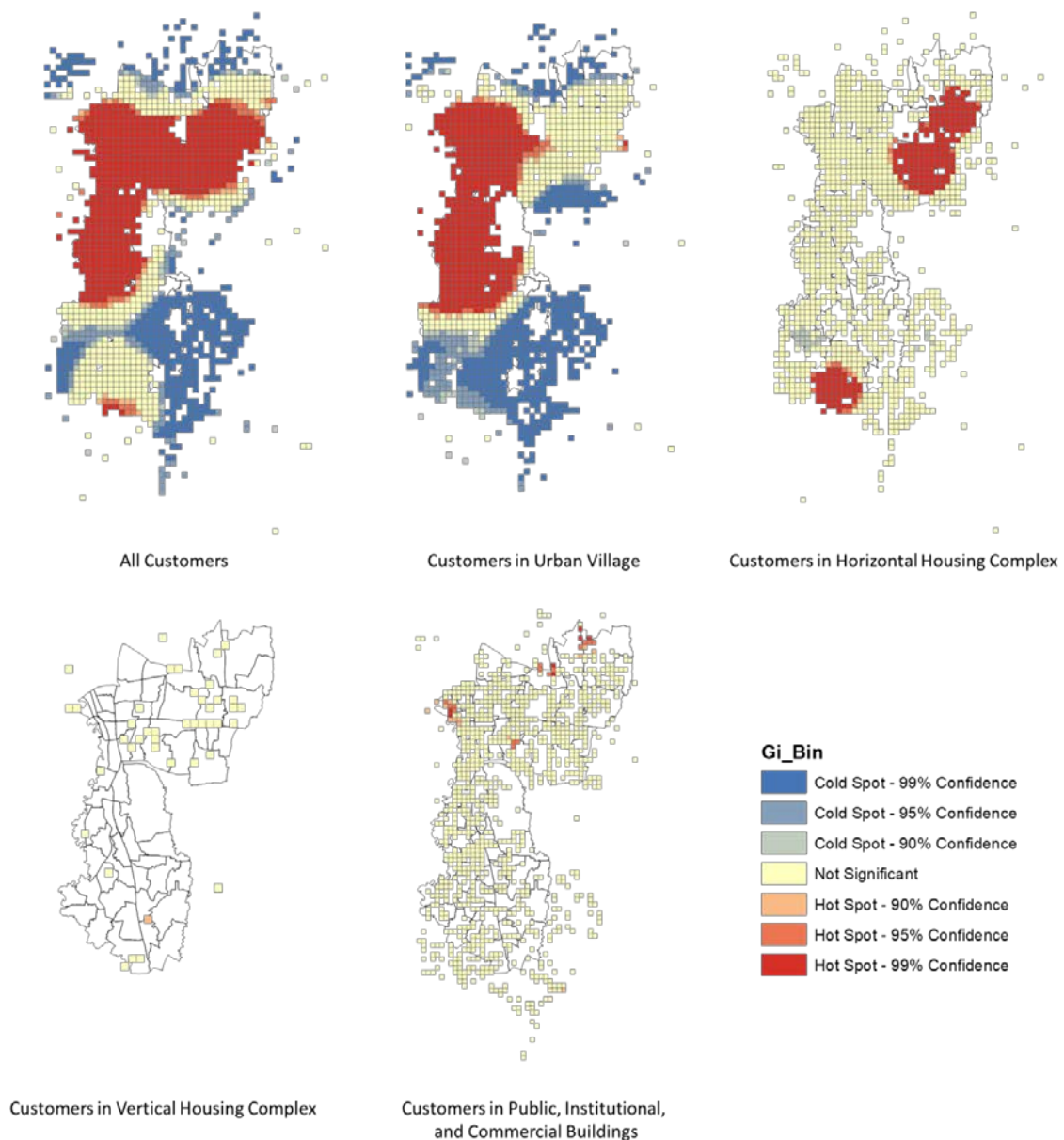


Figure 4. Getis-Ord test visualization of fishnet grid.

Customers in vertical housing complex area spread upon certain smaller areas compared to other residential areas. It is caused by the number of vertical housing complex in East Jakarta operational area which relatively smaller than other residence types and most vertical housing complexes are still under development phase. But, as the number of vertical housing complex increases in the next future, vertical housing complex can also be targeted as the potential target market. Moreover, the customers in buildings for other than residential purpose also scattered in wider area as public facility, institutions, and commercial buildings are spread throughout the study region. There are only small clusters of hot spots for buildings that formed by small industrial regions.

The results of temporal trend analysis for each customer category can be seen in Table 1. The results show that there are significantly increasing temporal trend of customer orders in the overall study region for all customers. The significantly increasing temporal trend of customer orders in the overall study region occurred due to significant increase of number of customers since August 2016 which continued onwards until March 2017. The increasing number of customer orders was encouraged by the existence of marketing strategy and development of fiber optic network by provider of fixed broadband service. The marketing strategy consisted of push strategy through marketing agents and pull strategies through promotion, call center, website, and phone application. Moreover, based on the analysis, the main factors causing the increase in the number of customers were 3 bulk migration programs offering more benefit with the same price to customers each of which conducted since August 29, 2016; from September 22, 2016 to February 28, 2017; and since February 13, 2017. The programs were conducted using upselling mechanism to avoid downgrade pricing and cluster based penetration priority on 7 out of 11 Private Automatic Branch eXchange (PABX) towers in East Jakarta operational area. They are PABX Cibubur, PABX Cawang, PABX Klender, PABX Pondok Kelapa, PABX Pulogebang, PABX Penggilingan and PABX Pasar Rebo, and 12 housing clusters at PABX Kraggan. Furthermore, the significantly increasing temporal trend can also be seen in dataset of customers in urban village, horizontal housing complex, and buildings for non-residential purpose. Customer in vertical housing complex is the only customer category dataset that has no significant temporal trend.

Table 1. Temporal trend analysis results for overall area.

Dataset	Trend Statistic	Trend P-Value	Trend Direction
All Customers	4.5330	0.0000	Increasing
Customers in Urban Village	4.5859	0.0000	Increasing
Customers in Horizontal Housing Complex	3.3263	0.0009	Increasing
Customers in Vertical Housing Complex	0.0000	1.0000	Not Significant
Customers in Public, Institutional, and Commercial Buildings	2.5083	0.0121	Increasing

The temporal trend analysis was further conducted for each location time series of the space time cube. Figure 5 shows the 2D visualization of space time cube temporal trends in each bin time series. The grids with purple colors show bin time series that has increasing trend, the grids with white color show bin time series that has no significant trend, and the grids with green color shows bin time series that has decreasing trend. The darker the color represents the higher the confident level of Mann-Kendall test results.

Based on Figure 5, it can be seen that the overall customer locations only have area with increasing temporal trend and area with no significant temporal trend, but no area with decreasing temporal trend of new customer number. It is also applied to customers in urban village, horizontal housing complex, and other buildings without residential purpose. Meanwhile, the decreasing temporal trend of new customer number occurs in vertical housing complex area which scattered in 3 bin time series, though there is also bin time series with increasing trend of new customer number in vertical housing complex area. The decreasing trend of new customer number in some vertical housing complex may be caused by penetration for a vertical housing complex requires a specific strategy with an approach specifically to the developer and management. Furthermore, it can be seen that the area with increasing temporal trend of all customers more gathered forming big cluster in urban center area, but more scattered in smaller cluster in sub-urban area. These facts indicate that the need of internet access keeps increasing, especially in urban areas that are contagious to the surrounding areas.

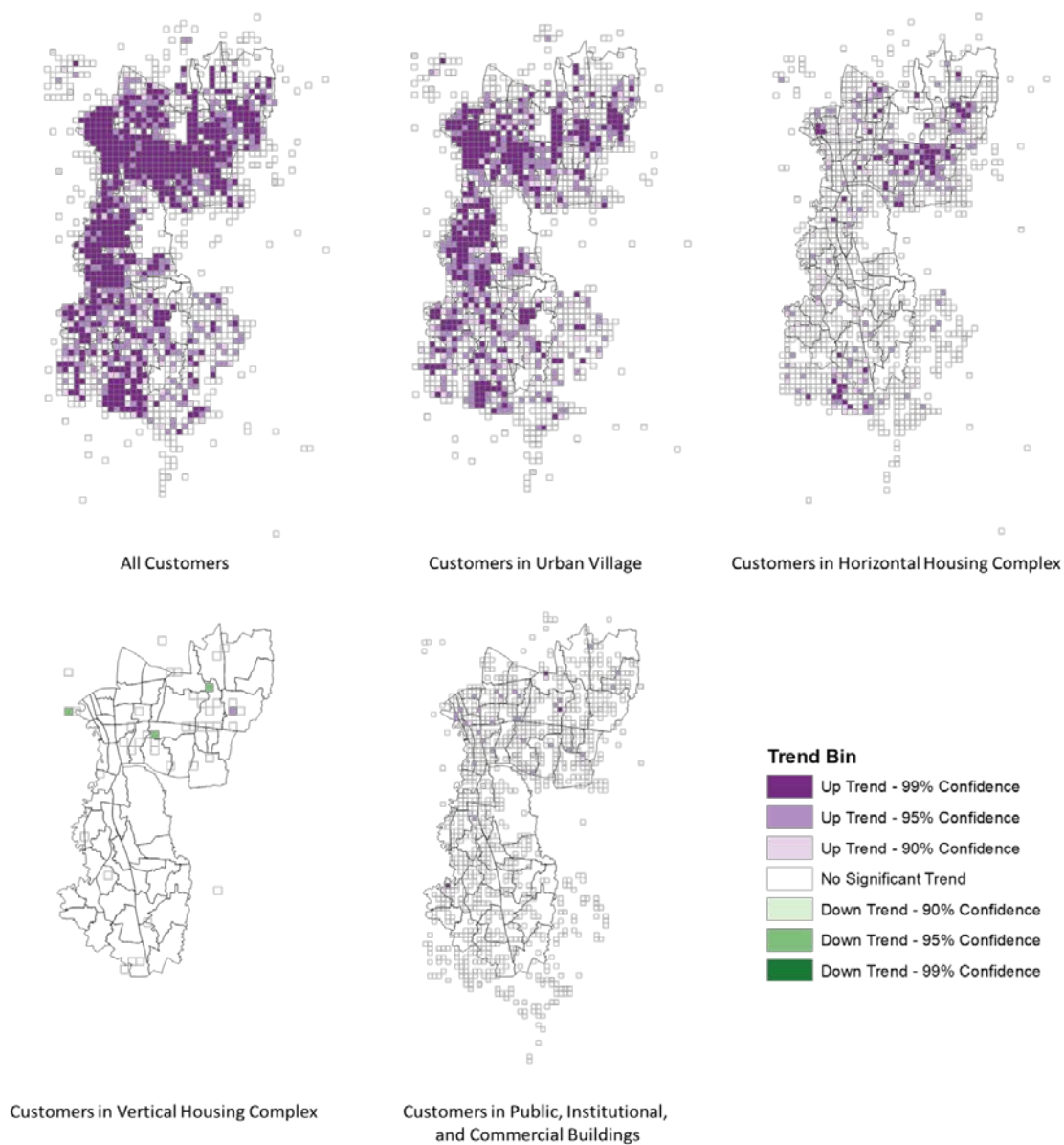


Figure 5. 2D visualization of space time cube temporal trends.

From the emerging hot spots analysis conducted by looking at the changes in spatial patterns over time in space time cube using the combination of Getis-Ord test and Mann-Kendall test. Figure 6 shows the 2D visualization of the results. Across dataset of all customers and four datasets of categorized customer differed based on customer type and location environment, the analysis identified six hotspot pattern categories, i.e. new hot spots, sporadic hot spots, oscillating hot spots, sporadic cold spots, oscillating cold spots, and no pattern detected as seen in Table 2. The new hot spots pattern means the most recent time-step interval is hot for the first time, the sporadic hot spots pattern means some of the time-step intervals are hot, the oscillating hot spots pattern means the most recent time step interval is hot but historically has been cold, the sporadic cold spots pattern means some of the time-step intervals are cold, the oscillating cold spots pattern means the most recent time step interval is cold but historically has been hot, and no pattern means that the location does not fall into any of the other hotspot patterns.

Table 2. Number of emerging hot spots category bins detected.

Pattern Name	All Customers	Customers in Urban Village	Customers in Horizontal Housing Complex	Customers in Vertical Housing Complex	Customers in Public, Institutional, and Commercial Buildings
New Hot Spots	0	0	0	14	5
Sporadic Hot Spots	0	4	54	0	29
Oscillating Hot Spots	396	332	0	0	84
Sporadic Cold Spots	14	7	0	0	0
Oscillating Cold Spots	6	4	0	0	0
No Pattern	1176	1116	930	28	868
Total	1592	1463	984	42	986

Figure 6 shows the 2D visualization of emerging hot spots of acquired customer in the study region of fixed broadband provider's East Jakarta operational area. Based on Figure 6, it can be seen that the emerging hot spots for all customers mainly occurs in the northern area. It is also applied for each customer category dataset. Moreover, even though customers in vertical housing complex have no significant temporal trend and significant hot spots, it can be seen that there are new hot spots formed based the emerging hot spots analysis which indicating the potential market of customers in vertical housing complex. Furthermore, it can also be seen that customers in buildings for non-residential purpose also have new hot spots in the southeastern area which indicating the development of sub-urban area and the increasing need of internet access.

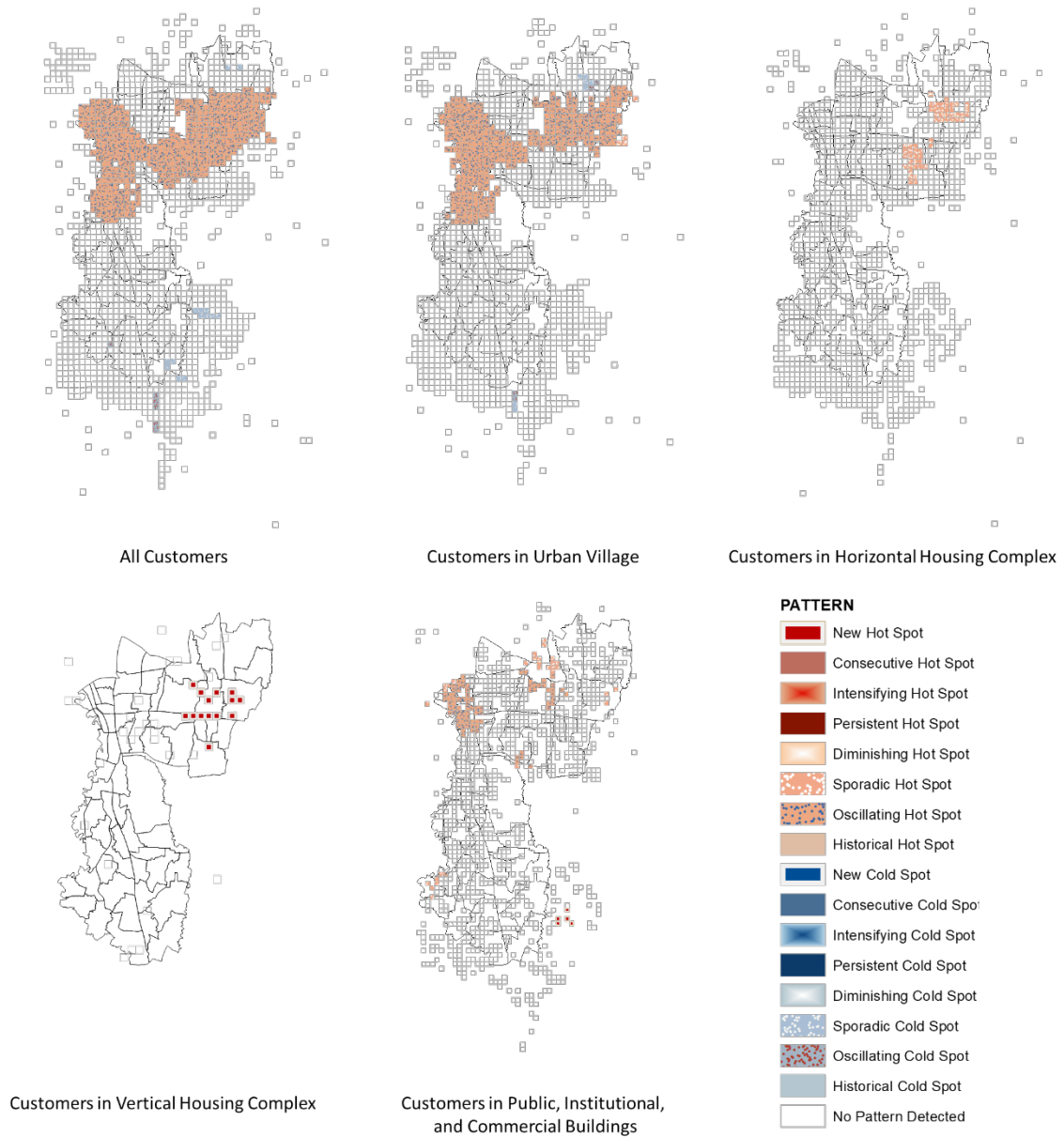


Figure 6. 2D visualization of emerging hot spots analysis.

The thematic maps resulted from data processing that show the distribution of hot spots area, location with increasing temporal trend of new customers, and emerging hot spots, can be used to support the decision making process regarding customer relationship management, asset and resource management, investment planning, and marketing strategy development. Based on results of the study, customer engagement and market penetration should be done in region-based cluster approach to gain and maximize the opportunities offered by upward temporal trend of new customer number, especially in the emerging hot spots. The developed strategy should consider type of customer category, as each customer category has different requirements and characteristic based on ordering purpose and location environment. For customer in vertical housing complex, the marketing strategy should be able to capture the potentiality of more customers in smaller area by creating collaboration with the vertical housing complex management as there were many new emerging hot spots of this category. In addition, the fixed broadband provider needs to assess the resources and assets in research scoped region whether the availability of current infrastructures can support providing reliable

service towards customers' increasing need of internet access in near future. Looking at the thematic maps, the infrastructure investment program in the northern and western area should be done using cluster approach based on the operational area of Private Automatic Branch eXchange (PABX) towers, while in the southern region it should be conducted using smaller cluster approach at housing level. Furthermore, the infrastructure development, rejuvenation, and maintenance program needs to be prioritized in the northern area to exploit the opportunities of acquiring new customers.

The application of spatio-temporal analysis in the fixed broadband provider helped the decision makers by providing them an overview of the growth and the distribution of customers related to their location environment characteristics in East Jakarta operational area. Through the application of spatio-temporal analysis, marketing strategies were developed in density based region, no longer in PABX tower coverage area based, because there were areas that have the potential to be continually developed which located in the border area of several PABX tower coverage areas. Furthermore, the customer area mapping also helped in setting priorities regarding areas to be prioritized for network infrastructure investment program and determining locations for telecommunication network modernization based on the number and density of customers.

4. Conclusion

Capturing the opportunities to provide support for company decision making process and strategy development, this research was conducted using spatio-temporal analysis in one of biggest fixed broadband provider in Indonesia which offers Gigabit Passive Optical Network (GPON) configuration. In this study, the analysis was conducted on the overall customer dataset and categorized dataset of customers which differed based on type of customer and location environment characteristics by exploring spatially the patterns, temporal trends, and emerging hot spots of customer distribution through fishnet grid and space time cube created from GIS-based dataset of customer order.

The results obtained from this study provide an overview of customer area mapping in the form of thematic map. The results show that customer area, especially customers in urban village and horizontal housing complex, tend to gathered forming clustered hot spots region. The cluster of hot spots area mostly occurs in high density urban village located at city centers and horizontal housing complex of mid-high society. Moreover, the overall temporal trend of customer acquisition number is significantly increasing, in which the increasing temporal trend of all customers gathered forming big cluster in urban center area, but more scattered in smaller cluster in sub-urban area as the need of internet access keep increasing and contagious to surrounding areas. The study also found that the emerging hot spots which reflecting the potential market area mainly happen in the northern area of this research scoped region.

As this research was conducted using statistical based method of spatio-temporal analysis, AI-based method can be applied for future research. Furthermore, the research was only conducted to generate consideration in supporting decision making process and strategy development process. The impact of the previous implemented strategies, that affect the distribution of customer area mapping, was not included in this research scope. Therefore, further research can also be conducted to assess the effectiveness and implications of the implemented strategies that have been undertaken to streamline company operations, penetrate market to acquire new potential customers, engage with current customers and improve service quality, maximize company revenues, and maintain company perpetuity.

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