BOUNDARY RE-ASSESSMENT OF THE METER READING UNIT (MRU) FOR TENAGA NASIONAL BERHAD, TNB CHERAS

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KEY WORDS: Boundary, meter reading unit (MRU), GIS, clustering analysis, network analysis

ABSTRACT:

The propensity of Geographic information systems (GIS) as a modelling tool for problems solving and spatial data analysis is remarkable and has been widely used in recent times. GIS applications has been utilized by Tenaga Nasional Berhad (TNB) in solving numerous problems. However, there are other units within the TNB where GIS can be extended and incorporated in order to improve service efficiency, reliability and operational success. Remote meter reading (RMR) technology has been successfully extended and maintain by TNB to more than 70% of highly consumed customers, which tremendously assist in improving meter reading processes and curtailed technical losses. But growing population within the cities and surrounding villages has been the major issue regarding bill distribution which the giant electrical distribution company must address squarely and timely. This paper therefore, employed the application of Geographic Information System in re-assessing the boundaries for meter reading units (MRU) using spatial analysis in order to reduced cost, travel time as well as other logistic requirements regarding billing distribution by TNB personnel. Clustering and network analysis has been employed to generate the new MRU boundary for TNB. The result of clustering analysis has been used to consider the location of customers in new suggested group of clusters, while the network analysis result generates shorter distance routes for meter reading. The results of the analysis can be validated with the analysis graph, where the patterns of the distance are compared in a graph which shows the distance generated from the new suggested cluster of new MRU boundary decrease incrementally compared with the distance of existing MRU routes.

1. INTRODUCTION

Tenaga Nasional Berhad (TNB), Malaysia's giant energy provider and one of the leading energy supplier in south east Asia serves over 8.6 million customers within peninsula Malaysia, Labuan and state of Sabah respectively (Ahmad, 2012) . The core activities of the giant energy supplier are in the areas of generation, transmission and distribution of electricity to residential areas, office buildings, schools and industrial areas among others (Ahmad, 2012). However, population explosion and higher demands for power has been the major concern of TNB in recent times. Initially, the process of billing distribution was not tedious as there were less number of energy consumers compared to recent time, but recent developments leading to high power consumption has made it almost impossible for meter reader and distributor to perform their functions effectively and timely (TNB annual report, 2010) . This is attributed to the facts that the number of installed meters in domestic areas, hospitals and other areas are higher and the reader cannot go round all the meter installation units for recording and billing distributions within short time.

The main function of electricity meters is to measure the amount of energy consumed by a customer (Chandan Soni et al., 2017). This measured data is usually read manually by meter reader in electricity distribution company and subsequently the data is being use in the preparation of customer's monthly consumption bills.

Moreover, the sole responsibility of the billing unit of TNB is to ensure profit maximization, efficiency, competency by having efficient and effective optimum reading and billing system in line with advance technology and mobile system (Energy Commission, 2014). Meter reading process conducted by TNB involves using an electronic device to collect energy data consumed and displayed either on a number dial basis or digital display (Palaniappan et. al, 2015).

However, with the high demands of energy due to population growth, routine for meter reading and billing distribution has been at the center of concern since electrical distribution company's priority is to maximize efficiency, ensure costless and effective operations that would bring purposeful development to the company and it is costumers (Sathya & Muthukumaravel, 2015).

In many countries around the world, meter reading system lacks proper communication mechanism that would send meter readings to power generation companies for real time billing and felt to address issues related to non-technical losses at various consumer premises (Alahakoon et al, 2016). Ordinarily, it would have been a long lasting solution to the power generation companies when power infrastructure has been integrated with information technology and communication features that would deliver power supply to it is various consumers.

Electricity generation companies that introduces the applications of smart meters with advance metering infrastructure has seen the advantage of using the system as compared to traditional metering systems (Depuru et al., 2011). Since power generation companies has been looking for an alternative solution that would monitor power consumption and flow control of electricity in domestics, offices and industries, the use of smart meter devices will be appropriate since it has a capability of obtaining meter readings from various consumers and automatically sends to the power company (Rodriguez et al, 2015). This would have been an alternative to the current meter reading and billing this study proposes, but because TNB have not yet implement the system, other alternatives most be employed to address the situation.

This study therefore, employed the application of Geographic Information System (GIS) for boundary re-assessment of meter reading unit (MRU). Network analysis has been applied to shorten the routes and time taking for TNB meter readers to effectively execute their task, while nearest neighbor analysis has been used in grouping the MRU in to sub-clusters of consumer premises.

2. METHODOLOGY

The methodology of this research has been developed based on the of objectives of the study. Figure 1 depicts the methodological flow chart of in a systematic step.

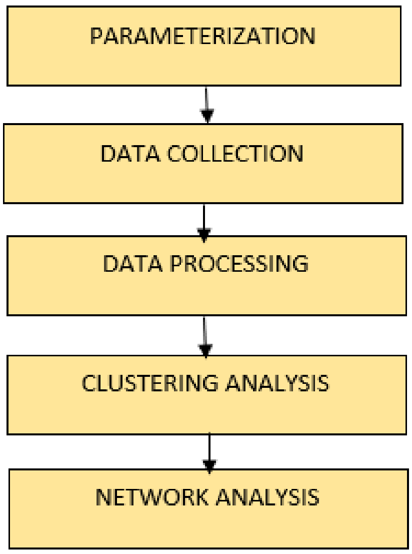

Figure 1 Flowchart of Methodology

2.1 Parameterization

2.1.1 Current Boundary Parameter

Parameterization is one of the most important technique in implementing data re-assessment boundary of MRU. The specification on defining the existing MRU boundary is related to this parameter. It further explains how dispersed and distributed is the customers' location for each MRU. As it has been said earlier, the meter reader is required to go to the customer's premises and take a records of customer's consumption at least once in a month for each respective consumer. The list from the meter readings consist of details information about their customer such as number or unit of meter reading (MRU), postcode, address, owners name and type of customer. Depending on the location some customers address falls on a certain group living far away from each other and as such the meter reader have to jump from farthest area to another farthest area for billing purpose.

2.1.2 Cycle Day Balancing and Route Optimizing

Cycle day Cycle day balancing is defined as the balance of meter reading workloads which will affect the entire meter reader's cycle days (Liberty Lake, WA, 2007). As an advanced solution, the electrical power generation company needs to create geographically compact cycle days, whilst minimizing the work load for particular day. This solution is able to develop the new cycle days balanced on duration of work, geographically compact and more efficient to read the meter. On top of this, route optimizing describes how to handle the meter route workday optimization by minimizing the distance of travel through any method and system that allow the meter reader to complete the list of meter reading (Bányai et. al, 2019). The identification of travel distance tends to help in identifying roughly the total distance involve for each MRU.

The relationship between the MRU and its corresponding areas are important. This has driven to improve the method which can be utilized in helping for preparation toward selecting better alternative. This will tremendously assist in improving the method that can be sustained towards selecting better alternatives.GIS technology is now famous in modern utility services that would define the optimum routing for meter reading.

2.1.3 Location of Customer

Location of customer is another important parameter utilized by TNB for the re-assessment of MRU boundary. It provides a meter reader with a full information about customer's premises (Singh, 2006). The location must be within the area covered by the TNB. This will equally assist in carrying out routine maintenance, since the meter reader already known the locations.

From the list of MRU, there consist some of customer location with their additional information such as postal code, address, district, premise account and others. So, from that address, the meter reader tends to know the fastest and suitable road to arrive at the customer's premises. Furthermore, in re-assessment the MRU boundary, customer's premises should be in grouping and not really disperse. It could minimize the distance that the meter reader covers for each unit

2.2 Data Collection

The data for this study has been provided by Tenaga Nasional Berhad (TNB). Open Street Map (OSM) is being used as a validation for other data received. Boundary re-assessment of MRU has been carried out in order to ensure new boundaries accuracy which can be used for future planning. Secondary data were drives from articles, journals, TNB's annual reports and technical documents.

2.3 Data Processing

Processing involves on this study basically by using clustering and network analysis. This analysis was chosen as one of the appropriate methods to re-assessment the boundary for MRU. At the end of this process, it would like to see roughly the total distance involved for each MRU after being clustered into a few groups.

2.3.1 Clustering Analysis

According to Tryfos (1997), clustering is the process of examining the collection of points and grouping the points into clusters according to some distance measured. The purpose of clustering is to group points that are in close proximity to each other and those far from each (Tryfos, 1997). This is commonly used to describe the point pattern analysis where it was purposely developed to help in describing the distributional pattern of geographical features objectively using statistical method. In determining the point pattern for this study, grouping analysis was used. Grouping analysis entails a classification procedure which attempts to find out the natural clusters within the data by specifying the number of groups to create (Schrader, 2013).

This analysis prioritizes the similarity of points within each group, and also distinguishes the groups where points are obviously dissimilar. The result generate by the group analysis can consist various shapes, size and densities. Attribute data of the features tend to reflect a wide variety of measurement and values (Schrader, 2013). The process of generating the clusters in ArcGIS software can be explained by looking at the flow of generated clusters depicted in Figure 2.

Figure 2 Flow of generate cluster in ArcGIS software

Figure 3 shows the pattern of raw points feature obtained during data collection. The point patterns are randomly located all over the study area. The information about this point can be seen from its attribute table such as X and Y coordinate, MRU and postal codes.

The selected field for the analysis involves numeric aspects, reflecting ratio and interval or ordinal measurement system (Cornelius, 2017). The information on field selection have been display in the group attribute. The result of group would be easier to interpret with a fewer field of analysis (ESRI, 2016). Furthermore, the number of group have been assign in relation for the study is where it has been generated for 16 group or cluster since TNB have provide 16 unit for meter reading.

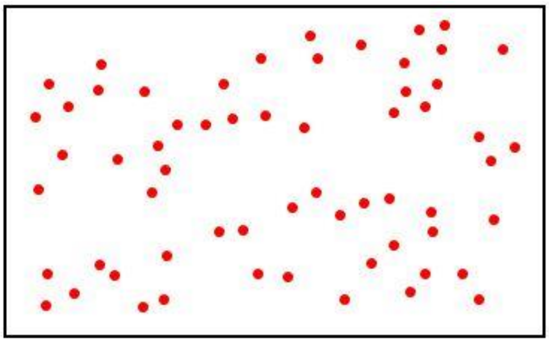

Figure 3 Pattern of points before clustering

Nearest neighbor is used as a spatial constraint for this analysis in ArcGIS software. The nearest neighbor illustrate the points features according to its distance from one point feature to the other another (Ahmed et. al, 2017). However, it does not only take a distance as its parameter, but also examines the closest point to it. Nearest neighbor was chosen in order to ensure proximity between all group members. The group of features assigned had at least one other point features as a natural neighbor.

The result for grouping analysis can be verified from Figure 4 below. The cluster of points features have been assigned based on their distance and nearest neighbor.

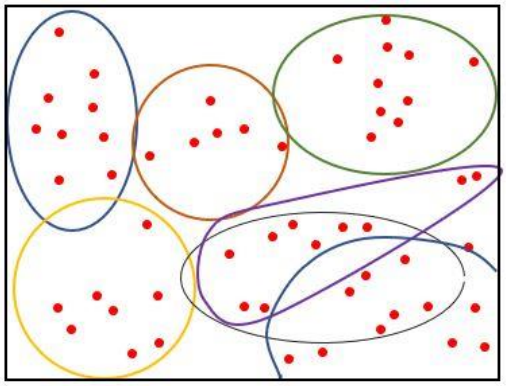

Figure 4 Pattern of point according to each cluster

2.3.2 Network Analysis

Network is a system of interconnected elements like edge (lines) and connecting junctions (points), which represent the possible route from one location to the other. The concepts of network consist of two categories which are geometric network and network dataset. River and utility network such as electrical, gas, sewer and water lines are example of geometric network while transportation network is a network dataset (El-Samak & Ashour, 2015).

Network analysis in ArcGIS is a tool that provides network-based spatial analysis to solve the complex routing problem (ESRI, 2019). Network analysis is applied here in order to determine the optimum or shortest route for meter readings. It enables addition and modifications of network location, generate direction, identify network features and build the network. The flow chart in

Figure 5 depicted on this paper shows the shortest route for each cluster generated from network analysis, which consist of 5 stages starting from data collections and terminated at the results.

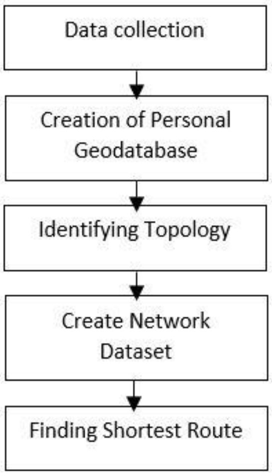

Figure 5 Flow for Network Analysis

The road network data, base map for study area and group of clusters have been prepared as the entire data needed for the analysis as shown in Figure 6. The base map covers the entire operational area of TNB Cheras which is obtained from Open Street Map (OSM). OSM can be accessed through ArcGIS Online Services while the base map requires internet connection to process the data. The road network data given by TNB contain the length of each road in meter (Length), name of each road (Name) and the direction of each road (Flow).

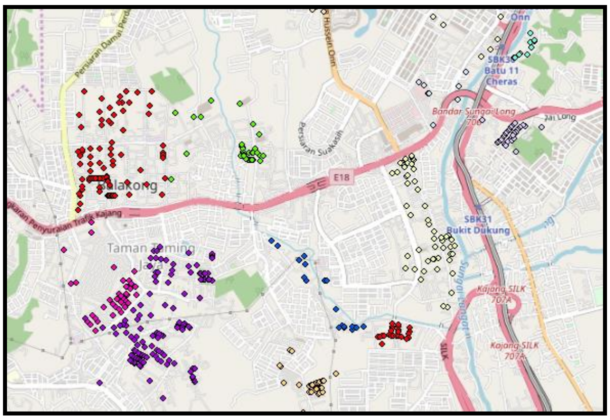

Figure 6 Data preparation for network analysis

Database of this study contains road network data and group of clusters since the personal geodatabase tend to stored, query and manage both spatial and non-spatial data (Ford et. al, 2015). Additionally, network topology is necessary for network analysis operation. This is because errors can be detected when building the topology of road network, so it can be corrected by eliminating the errors. The topology has been executed by applying a few rules such as ensuring no dangles in the road network and the road do not overlap or intersect with themselves.

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The network dataset can be proceeded after correcting the road network errors. In order to create network dataset, the line features class represented as the road network has to be stored as feature dataset in geodatabase. The network dataset is good enough to model the network for transportation since there have been a proper connectivity from one edge to another edge.

Lastly, ArcGIS Network Analyst Extension tools consist of network based spatial analysis including route analysis, service area analysis, closest facility analysis, vehicle routing problem analysis and location-allocation analysis. The shortest route analysis has been applied for re-assessments of the MRU boundary where it generated the shortest route between two locations. Figure 9 shows the direction of routes, starting from various pick up locations.

3 RESULTS AND DISCUSSION

The comparism between the total length of each MRU and that of a clusters have been provided in the results. Figure 7 shows the result of 16 group of points according to their similarity such as MRU, street area, distance and others, while Table 1 represent the total points for each new cluster. From Table 1 and Figure 7, it can be seen that cluster 12 and cluster 15 have more points compare to other clusters. This is due to the relationship with the analysis of field chosen, such as X and Y coordinates, postal code, zones and name of streets., zones and name of streets.

Table 1 Total points for every cluster

Cluster	**Total of Points**	**Cluster**	**Total of Points**
1	10	**9**	15
2	28	**10**	32
3	25	**11**	42
4	18	**12**	84
5	51	**13**	64
6	54	**14**	51
7	11	**15**	83
8	35	**16**	62

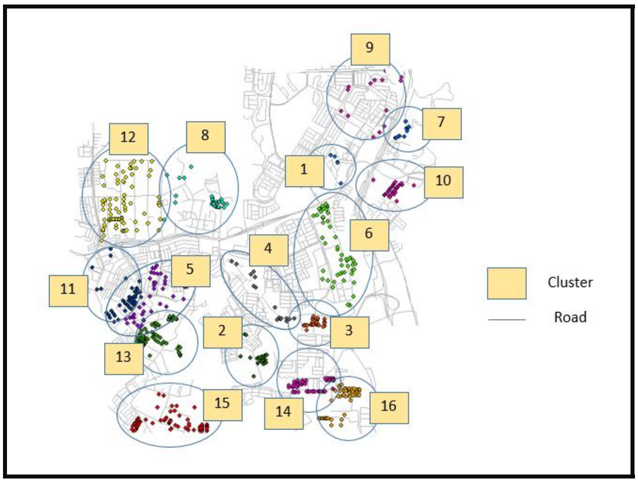

Figure 7 16 cluster of points generate from grouping analysis

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The existing GIS data and potential complex structure of cluster analysis results necessitates the representation of the results at different levels of abstractions. Sub-clusters exist in some of the clustering units and therefore have similarities to each other, and have shortest distance to each other. An opportunity to show the best result of clustering would improve visibility of the result and would be able to simplify the process of decision making during GIS data interpretation (Ham felt et. al, 2017).

The clustering data has been utilized for network analysis results. The built-in network must go through every point found in each cluster. The purpose is to know roughly the total distance meter reader need to pass for each cluster. According to Figure 8, the total distance for all points in Cluster 11 is 5.4 km for 32 points representing the customers. This route represents the shortest distance that the meter reader need to pass from Location 1 until Location 10.

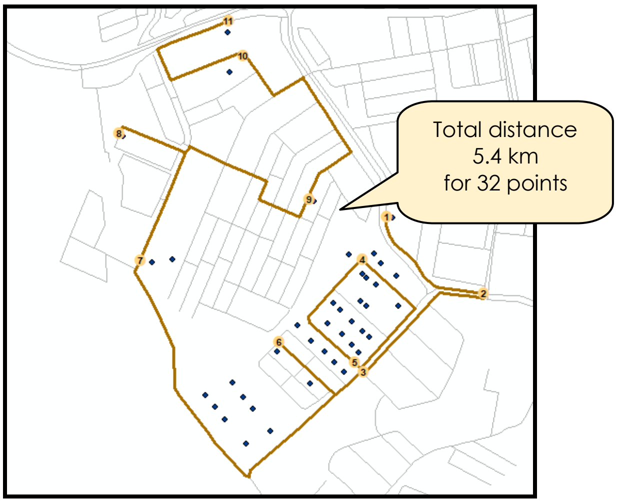

Figure 8 Total distance for Cluster 11

The findings of the shortest route can be represent graphically as shown in Figure 9 showing all the direction starting from first location to the next location. The information about this direction has been obtained from group attribute table.

Figure 9 The shortest route directions result

Finally, the validation of the new clusters is by comparing the distance of the existing MRU against the distance of its new suggested clusters as shown in Table 2 and Figure 10. From Figure 10, it can see that the distance of MRU 15300067 decreased significantly from 6.4 km to 0.8 km. This is due to the customer's points being dispersed before embarking on clustering analysis. Therefore, this analysis can help in maximizing efficiency and the total travels time, maximizing travel reliability, minimizing fuel consumption and reduces cost significantly for TNB.

Table 2 Total points for each cluster with their distances

Unit of Meter Reading (MRU)			**Group of Cluster**		
No.	Distance (km)	Total of points	No.	Distance (km)	Total of points
MRU 15300067	6.4	31	**1**	0.8	10
MRU 15300069	5.9	28	**2**	2.1	28
MRU 15300068	4.7	35	**3**	1.4	25
MRU 15300074	15.5	44	**4**	13.4	18
MRU 15300359	8.4	18	**5**	8.7	51
MRU 15300356	15.4	40	**6**	5.4	54
MRU 15300677	25	30	**7**	0.6	11
MRU 15300070	4.5	28	**8**	6.0	35
MRU 15300366	3.5	18	**9**	5.0	15
MRU 15300353	7.5	49	**10**	4.5	32
MRU 15300365	22	75	**11**	5.4	42
MRU 15300072	13.8	89	**12**	10.4	84
MRU 15300355	18.7	100	**13**	4.3	64
MRU 15300362	19	80	**14**	2.0	51
MRU 15300071	11.9	16	**15**	4.8	83
MRU 15300073	4.5	79	**16**	4.3	62

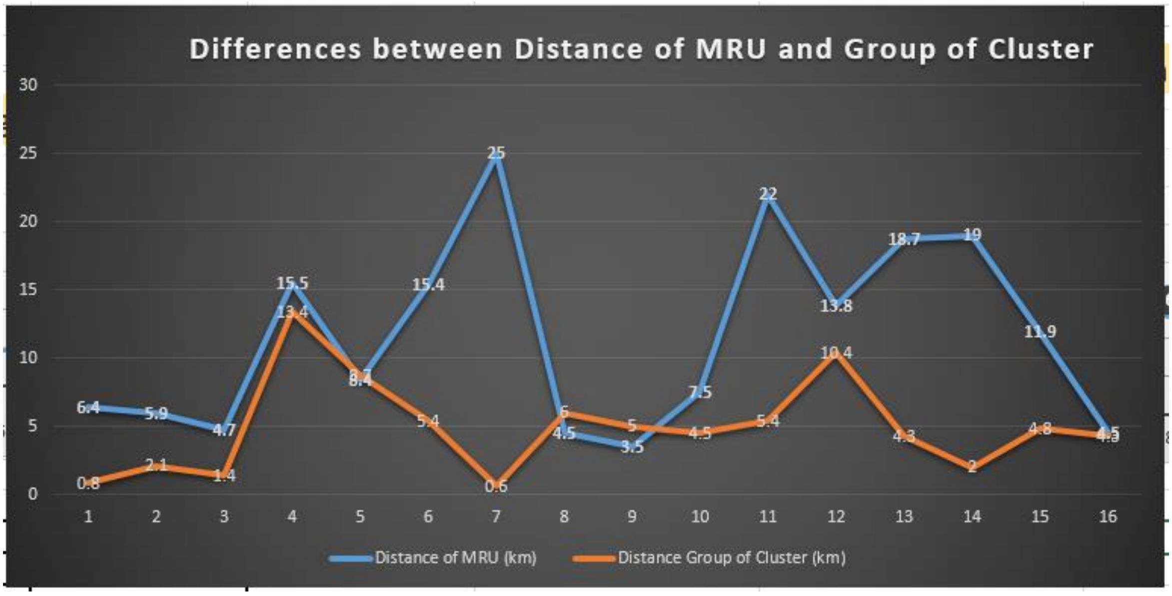

Figure10 Graph differences between distance of MRU and Group of Cluster

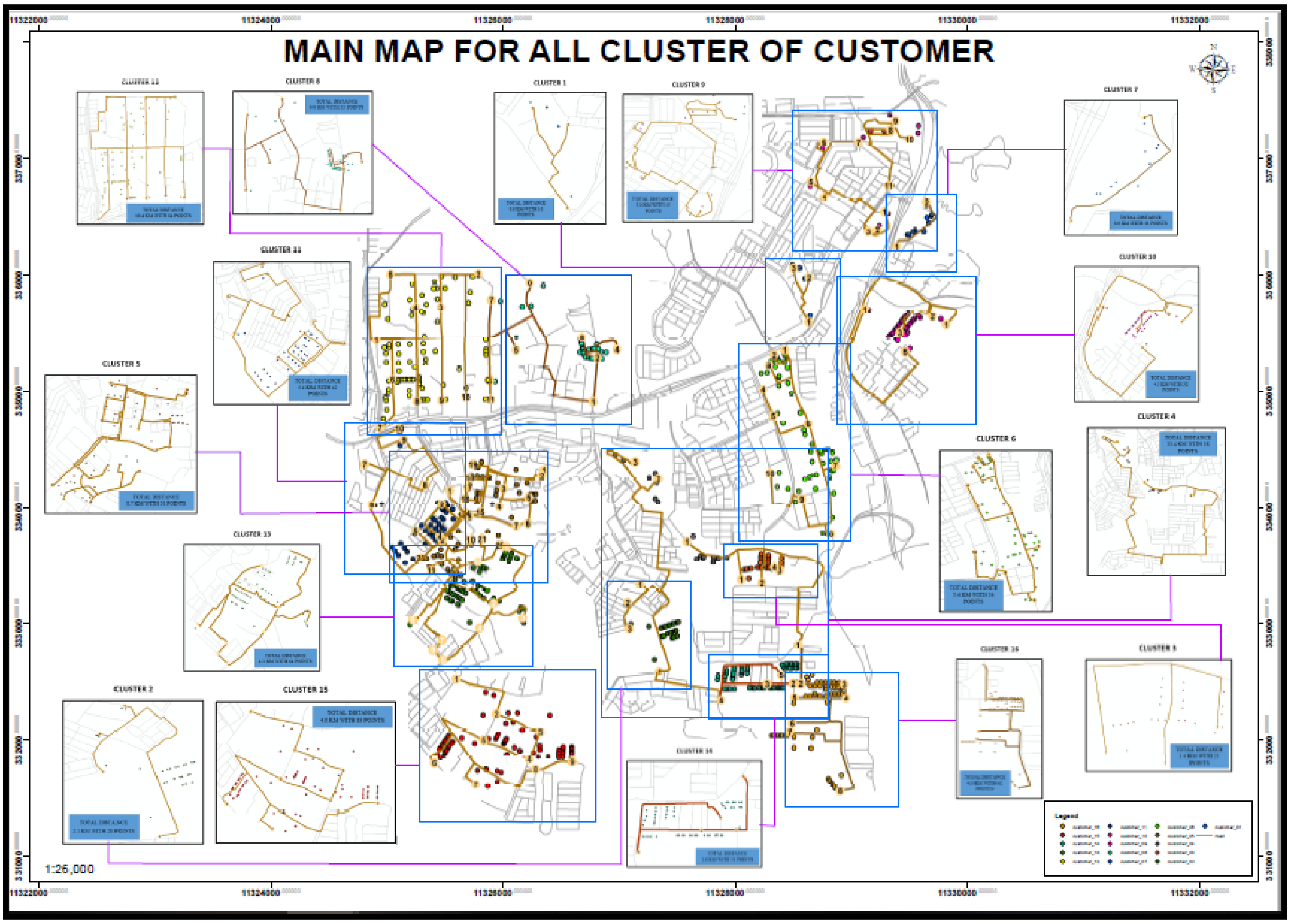

Figure11 Main map for all clusters

Element of GIS in this study have been applied when creating the map for overall points as well as each cluster of points. Therefore, it will have 16 maps (Figure 11) with each cluster and one main map (Figure 12) that represent all the points with their proper shortest route.

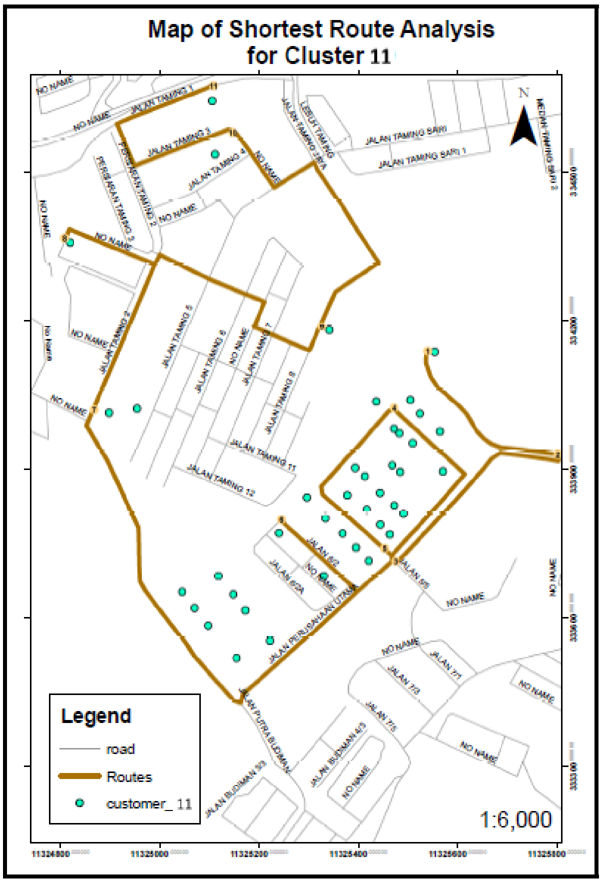

Figure12 One of the maps of cluster points

2 CONCLUSION

In this study, spatial analysis techniques such as clustering and network analysis has been applied in re-assessment of meter reading units (MRU) of TNB. This techniques are most relevant in generating the new MRU boundary for meter reading compare on the previous method used by TNB which is they assign the boundary based on the same name of road and their operational area.

Clustering and network analysis are better than the existing method since the results of the analysis are beneficial to the TNB as it helps the power distribution company to increase it is annual profit, maximize efficiency, reduce travel time, maximized travel reliability, minimized fuel consumption and general reduction on most expenses.

Point clustering using nearest neighbor analysis has it is own limitations, especially when size of a particular region has not been taking into considerations. Generally, the study produces two major outputs with one showing the general map of shortest routes and secondly the map of each cluster. The result also validated the pattern of distance between existing MRU with new cluster as in graph.

ACKNOWLEDGEMENT

The authors would like to take this opportunity to extends their profound gratitude and sincere appreciation to the managements and staffs of Tenaga Nasional Berhad (TNB) for their support and provision of the required data. Our utmost gratitude goes to Universiti Teknologi Malaysia for supporting this study.

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Revised August 2019