Jurnal Teknologi

Full paper

Conceptual Design of Malaysia Geopostcode System

Wan Mohamad Nazmeen Wan Othman[a], Zainab Mohamed Yusof[b], Shahabuddin Amerudin[c*]

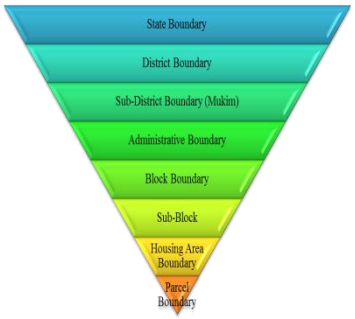
[a]AAM Pty. Ltd., J-3A-12, Solaris Mont Kiara, Jalan Solaris, Mont Kiara, 50480 Kuala Lumpur, Malaysia
[b]Department of Hydraulics and Hydrology, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Malaysia
[c]Department of Geoinformation, Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

*Corresponding author: shahabuddin@utm.my

Article history:

Received :6 February 2014
Received in revised form :
21 December 2014
Accepted :26 February 2015

Graphical abstract



Abstract

The existing postcode hardly works to use in navigation and not precise due to large geographical area coverage. Therefore, development of alphanumeric spatial postcode (geopostcode) conceptual design is very crucial. The hierarchical aggregation of spatial boundaries is used to develop this alphanumeric geopostcode. This eight alphanumeric characters geopostcode can gives a thousand benefits to the users in term of navigation and time consuming. This geopostcode are very important in many sectors in Malaysia especially in Location-Based Services (LBS) application. By implementing of this geopostcode model, the time consuming for searching the address will reduce and increase the preciseness of the location placement. It is can be more flexible, easy to understand, easy to implement and promote data consistency, economic and social developments, governance, public participation and sharing with all participating entities. This new geopostcode hope will achieve greater usability need and to make the postcode as familiar to the person as their telephone number and plate number of their car as well as it is more likely to be memorized.

Keywords: Postcode; geopostcode; hierarchical aggregation; LBS

Abstrak

Poskod yang sedia ada sangat sukar digunakan untuk tujuan navigasi dan kurang tepat akibat liputan kawasan geografi yang luas. Oleh itu, pembangunan konseptual model poskod spatial berasaskan aksara (geoposkod) adalah sangat penting. Pengagregatan hierarki sempadan ruang digunakan untuk membangunkan geoposkod. Geoposkod yang berasaskan lapan aksara ini diharapkan boleh memberikan beribu manfaat kepada pengguna dari segi navigasi dan penjimatan masa. Geoposkod ini adalah sangat penting dalam pelbagai sektor di Malaysia terutama di aplikasi Perkidmatan Berasaskan Lokasi (LBS). Dengan menggunakan model geoposkod ini, penggunaan masa untuk mencari alamat akan dapat dikurangkan dan meningkatkan ketepatan penempatan lokasi. Ianya sangat fleksibel, mudah difahami, mudah untuk dilaksanakan dan menggalakkan keseragaman data, perkembangan ekonomi dan sosial, pentadbiran, penyertaan awam dan perkongsian dengan semua entiti yang mengambil bahagian. Diharapkan dengan adanya geoposkod baru ini akan dapat mencapai keperluan kebolehgunaan yang lebih besar dan menjadikan geoposkod ini biasa kepada pengguna seperti penggunaan nombor telefon dan nombor pendaftaran kenderaan yang sangat mudah diingati.

Kata kunci: Poskod; geoposkod; pengagregatan hierarki; LBS

1.0 INTRODUCTION

A postcode is the fundamental and essential element of a modern address with numeric and/or alphanumeric characters. It is a series of numbers representing specific areas within a country. Most postcode or postal codes are numeric. The few countries using alphanumeric postal code systems (with letters and digits) are, Argentina, Bermuda, Brunei, Canada, Jamaica, Ireland, Netherlands, United Kingdom and Venezuela.[1] In Malaysia, postcodes are in a series of five numbers.[2] And this postcode is not spatially connected with coordinates.

Due to growing demand in Global Positioning System (GPS) device, smartphone, in-vehicle navigation systems, location-aware cellular telephones, and many expected new products, so a spatially related postcode should be implemented in Malaysia. Old-fashioned and rustic addresses like: "*Lot 56, Taman Jaya Setia, Jalan PCB, 15350 Kota Bharu, Kelantan*" are still being used in many parts of the country and also in Malaysia especially to find address in address locator like Google Earth and Google Maps.

These require local knowledge and slow up courier companies and emergency services. In United Kingdom, the postcode used is in alphanumeric.[1] These alphanumeric are the reducing from the long address. For example in Westminster, the address is, *10,*

Downing Street, Prime Minister and First Lord of the Treasury and its short alphanumeric postcode is SW1A 2AA. Another example is, *11, Downing Street, Chancellor of the Exchequer* and the postcode is SW1A 2AB.[3] The alphanumeric in the postcode represents the details which can be referred such in Figure 1.

Figure 1 Hierarchical division structure of alphanumeric postcode in United Kingdom

The study by NAPA evaluated the needs of geographic information in the 21st century especially postcodes that are spatially connected (coordinates).[11] Address information is important to assessors, appraisers, real estate agents, emergency services, mortgage lenders, redistricting, location-based services and other users. In fact, the billion dollars business geographic industry is founded on the concept that an address can be assigned to topologically correct geographic coordinates and that the address can be used to navigate to the correct locations. Thus, there is a great demand for an accurate and precise street address data file for a numerous of business and public applications. So the eventual geopostcode solution is not aimed at sorting mail but rather at defining the destination precisely.

Coordinate based geographic addresses becomes even more important resulting an increasing usage of GPS and cellular telephones that enable location based emergency and retail services to a mobile public.[4] LBS that involves in GPS applications, mobile telecommunication, intelligent ambulance response, cable television, etc. are new and rapid areas of economic and technology developments. LBS require a functional addressing system, that is, the general public and business community, including visitors, is able to easily navigate, locate and access to places of interest.[5] Furthermore, in the context of a globalizing economy, rapid geoinformation development and the importance of easy and accessible local, regional, country and international communication are very essential.[6] The postcode has evolved into a crucial tool for postal organization and consequently postal development.

There are some addressing issues in Malaysia. One of the issues is lack of consistent data for references. House numbers are also arbitrarily distributed in many places. There is frequent redundancy in naming and variations in spelling and labelling.[7] Some people are keeping confusing between destinations with a similar name. An exemplary is tabulated in Table 1, which is referring to addresses in Malaysia. The address also is very inefficient to use in navigation purposes. It is because not only having many components and long characters string but it is also inconvenient to input into computers or other navigation device. As a result, users need to spend lots of time for entering long numbers of coordinates or long characters string of address. Besides, addresses also do not related to geographic coordinates and need to be geocoded before displaying them on map.

Table 1 Places that have similar name in Malaysia

No.	Place	State	Total
1.	Taman Bandar Baru	Kedah	2
2.	Taman Bandar Baru	Selangor	1
3.	Taman Bandar Baru	Negeri Sembilan	1
4.	Taman Bandar Baru	Perak	2

Another problem is due to many different formats and units such as decimal degrees, decimal, degrees/minutes/second that add a lot of extra work in format and unit conversion.[7] A few format for writing Latitude and Longitude coordinate (e.g. Johor Bahru, Malaysia) are:

i) Decimal Degree: N1 27.81071 E103 45.28301
ii) Decimal: 1.463512, 103.754717
iii) Degrees Minutes Seconds: N1°27' 48.642", E103° 45' 16.981"

Besides that, geographic coordinates require lots of characters (numbers) that will causes a long time consuming in order to enter the long number of coordinates in the location finder like Google Earth and Google Map as well as in GPS device. Mistakes also can be done in inserting the coordinate numbers. Thus, this study aimed to design and propose a functional framework of the alphanumeric geopostcode based on GIS for fast and precise addressing that has been developed in some countries for various purposes.

2.0 EXPERIMENTAL

2.1 Framework Structure

The important step of the research methodology is a preliminary study on the research topics. In order to fully understand the research topic, the background of knowledge needs to be equipped by doing as many as literature research such as collecting the reading materials on the related research topic.

Once the literature reviews has been completed, a method of how the research should be conducted was identified. By using previous research as references, the next process becomes more easily to get done. This includes the study of the structure postcode in Malaysia and also several other countries around the world like United Kingdom, Ireland and Canada that has been used an alphanumeric postcode as their addressing system and also for navigation.[8]

2.2 Hierarchical Aggregation of Spatial Boundaries

The hierarchical aggregation approaches based on Figure 2 was used in the present study. The geopostcode can be structurally designed from the largest boundary to the smallest parcel boundary. That means, the geopostcode is structured hierarchically, supporting 8 levels of geography unit boundaries:

1. State boundary (There are 15 states in Malaysia including Wilayah Persekutuan)
2. Districts Boundary (Johor Bahru has 10 Districts)
3. Sub-district (Mukim) boundary (There are 9 sub-district in the district of Johor Bahru)
4. Administrative Boundary (There are 4 administrative that covers in Johor Bahru district)
5. Block (Indicated the Blok Perancangan (BP) MBJB towards 2020)
6. Sub-Block (Blok Perancangan Kecil (BPK) MBJB)
7. Housing Area

8. Parcel Boundary/Geopostcode boundary (It is the small area that covers parcel lots)

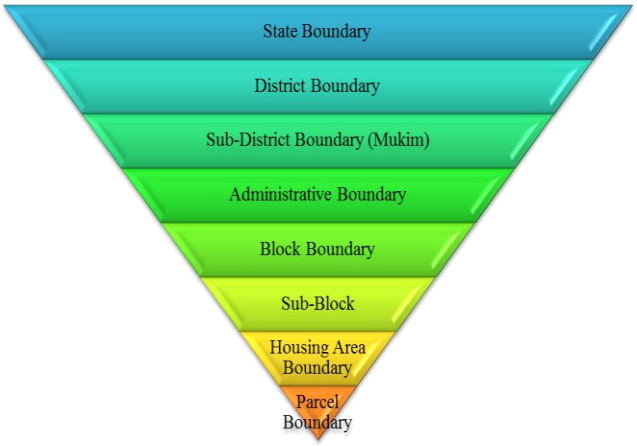


Figure 2 Hierarchical level of geography used in designing geopostcode

Disaggregating the housing area further into a small resolution area of parcel boundary would create another level of unique intelligence.[9] This should effectively address the issue of multiple streets sharing the same name within the same boundary. This makes the geopostcode further lend credibility to its ultimate usefulness.

2.3 Geodatabase Structure

The geodatabase is developed to gather all the spatial data of a study area in a structured data storage system to facilitate and support data access in this study. The resulting developed geodatabase can be seen as shown in Figure 3 using ArcGIS version 10 (ArcCatalog). The database that has been developed was compiled in a Personal Geodatabase, named MBJB and has been divided into 4 feature datasets which are Block, Boundaries, Centroids and Features.

The feature datasets are objects that allow users to group together related feature classes. It can be used to group feature classes that are stored in the same coordinate system, participate in topology and also feature classes that are part of a geometric network, network dataset, or terrain dataset. Each of this feature dataset consists of several feature classes. When the feature dataset is expanded in the ArcCatalog tree, it can be seen all the feature classes and other data objects were in it, as shown in Figure 3 below.

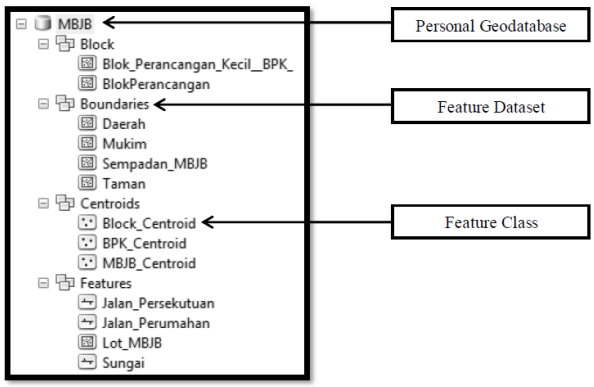


Figure 3 Framework structure of geodatabase in ArcGIS 10

There are eight layer boundaries data needed to develop the geopostcode. Each layer of geographical features boundaries in ArcGIS 10 and its data type are illustrated in Figure 4.

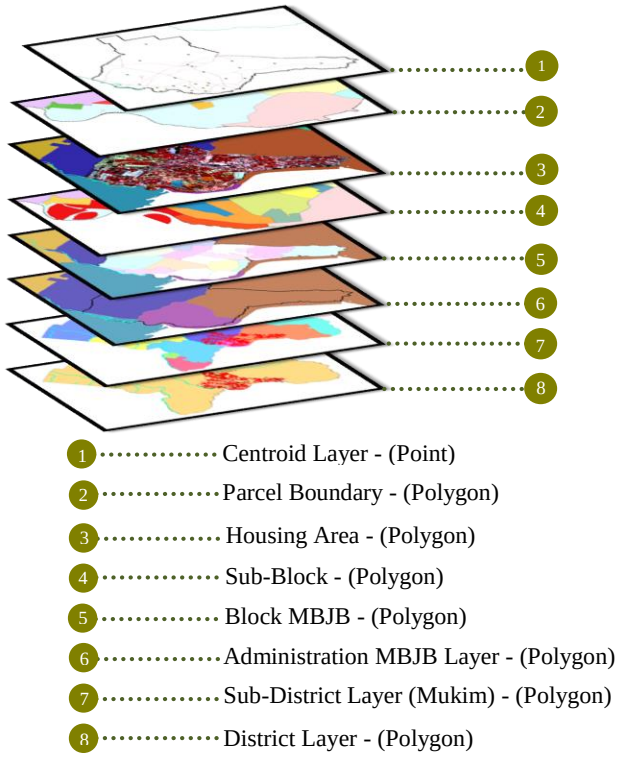


Figure 4 Data layers used in ArcGIS 10

2.4 Designing Geopostcode Structure

The alphanumeric systems can give the same number of digits, encode many more locations. For example: If we are given a 2 digit numeric code then we could code 9 x 9 = 81 locations. In contrast to a 2 digit alphanumeric code, for example to have 26 possibilities per character would then have 26 x 26 = 676 possibilities. Of course the number of possibilities would increase when the numbers of characters increase, and also when the both type of characters are combined. Therefore, it is often more precise than numeric. Based on the spatial data which are the polygon area boundaries, the most optimum number of characters proposed is eight characters. Canada is one of the countries that used eight alphanumeric characters as their spatial postcode. When the entities of the layer are less than nine, numeric characters are assigned for that layer boundary and alphabet character will take place when it is more than nine entities. These are the basic rules anticipated when designing the algorithm structure. The proposed geopostcode structure is alphanumeric with the following six valid algorithm permutations as tabulated in Table 2. This proposed algorithm structures are based on the data layers and the basic rules of assigning the code, shown in Table 3.

Table 2 Structure of geopostcode algorithm

No.	Proposed Algorithm Structure
1	AAN-NA-AAN
2	AAN-NA-ANA
3	AAN-NA-ANN
4	AAN-AN-AAN
5	AAN-AN-ANA
6	AAN-AN-ANN

A refers to Alphabets (A – Z) = 26 total alphabets
N refers to Numeric characters (1 – 9) = 9 total numbers

Table 3 The proposed type of character chosen for each layer of study area

Layer	No. of Entities	Type of Character
States	15	Alphabet (A)
Districts	10	Alphabet (A)
Sub-Districts	9	Numeric (N)
Administrative	4	Numeric (N)
Blocks	16	Alphabet (A)
Housing Area	16	Alphabet (A)

These proposed geopostcode framework are consists of three halves: the separation between first, second and third parts is indicated by a defined separator, a dash (-). Dashes make it easier to break up the area and location. The first geopostcode parts [AAA] cover a large unique area down to sub-district (Mukim) boundary. While the second or middle part [AN], covers the administrative boundary and the third geopostcode parts [AAN/ANA/ANN], indicate the combination form of the housing area and the smallest area of parcel boundaries, and this consist of average about 15 parcel lots only, depending on the area size. All of the alphabets in this structure are using capital letters.

2.5 Requirement of Geopostcode Characters

There are a numbers of requirements when designing the geopostcode characters:

i) It should be short and memorability
ii) It should be clear
iii) It should be flexible
iv) It should be logical

2.5.1 Short and Memorability

This geopostcode are purposely designed with eight characters that representing seven hierarchical layer boundaries. Eight characters is the optimum total number that normal human being can memorize. Look at the phone numbers and car's plate numbers, most of them consist of up to eight characters. The postcode in United Kingdom used up to seven characters while Ireland using 8 alphanumeric characters as their postcode which known as Loc8.[10]

The combination of numbers and alphabets would maximise the potential for memorability. The geopostcode must be short and memorable so that it will gain maximum usage for public users.

2.5.2 Clear

The term 'clear' in this context means that the character used may not led to confusion to people. Some alphabets can be seen similarly to numbers and vice versa. In United Kingdom, the letters 'C', 'I', 'K', 'M', 'O', and 'V' usually do not used in the postcode to avoid confusion scanner. It is because these letters will cause the wrong interpretation of the mail sorting machine. For this geopostcode, some alphabets have been filtered out so that it will reduce the level of confusion to people.

Letters 'B', 'I', 'O', 'S' and 'Z' are not appear in the second character until eighth characters in this geopostcode. It is because people can get confused with number 8, 1, 0, 5, and 2 respectively. It's also can avoid spelling errors when involve in handwriting. But these letters only can be used for the first character only. This geopostcode character seen very clear as it is avoiding characters confusion.

2.5.3 Flexibility

These geopostcode can be used for addresses, locations, point-of-interest, petrol stations, parks and other geolocation data. It is because it consists of alphanumeric which has thousands possibilities of geopostcode. It is also can be used by public and many sector, not just a specific user.

2.5.4 Logical

Punctuation marks are totally not used in this geopostcode to avoid problems and conflict in database. The punctuation marks consist of: % ' ' ( ) * + - , . / \ : ; < > = ! _ & ~ { } | ^ ? $ # @ " [ ]. Exceptional are given to the dash mark (-) to be used in partitioning the geopostcode. To date, there are no countries in the world that used the punctuation marks in designing the postcode structure except some countries like Ireland (Loc8) that just using the dash mark.[10]

2.6 Relevant Geopostcode Characters

To identify relevant geopostcode characters, selection criteria need to be formulated. This selection process is very important and the crucial part. It is because to make sure the geopostcode characters are reliable, short and easy to get remember. In order to keep effectiveness and publicly used of this geopostcode, the number of characters used must be as minimum as possible and it must be very optimum so that people can easily to get memorize the geopostcode and user friendly.

2.6.1 First Geopostcode Part [AAN]: First Character

The first level character of this geopostcode system represents the states in Malaysia, shown in Figure 5. It is an abbreviation for the largest area within the country, which is states boundary. This character was indicated by an alphabet. There are unique 15 states in Malaysia including Wilayah Persekutuan Kuala Lumpur, and Wilayah Persekutuan Labuan. Any addresses within Malaysia would definitely fall within one state. So each state must have a unique postcode to start with, as shown in Table 4.

There are some options that can be used as the first character, which means the first level of the geopostcode. One of these options is the usage of initial letters of each state such as letter T for Terengganu, J for Johor and N for Negeri Sembilan. Unfortunately, the use of the initial letter of each state name is certainly not effective and can't be used due to redundancy factor. There are several of states that having the same initial name such as K (Kelantan, Kedah), S (Selangor, Sabah, and Sarawak), P (Perak, Pahang, Pulau Pinang, and Perlis).

The used of more than one characters is totally not relevant and less optimum. It will increase the number of characters and reduce the preciseness of the geopostcode. Alternatively, the unique vehicle registration plate number of each state in Malaysia can be used as a first character of this geopostcode. So there will be no redundancy of characters occur. The algorithm started with an initial alphabet of the vehicle registration plate number of each state. The chosen of first characters geopostcode is quite easy to

define because the number of states in Malaysia is static. It is very difficult and seems impossible to increase and reduce the number of states.

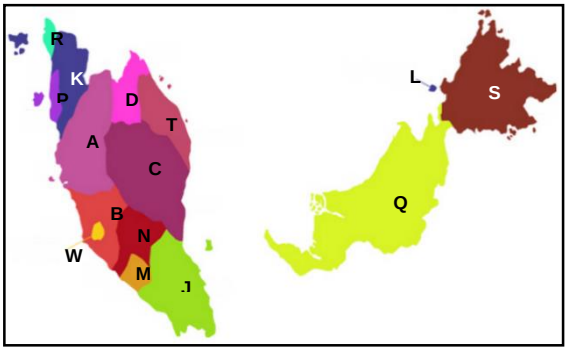


Figure 5 The initial alphabet of vehicle registration number of each state in Malaysia

Table 4 First unique code assign for each state in Malaysia

Code	State
A	Perak
B	Selangor
C	Pahang
D	Kelantan
J	Johor
K	Kedah
M	Melaka
N	Negeri Sembilan
P	Pulau Pinang
Q	Sarawak
R	Perlis
S	Sabah
T	Terengganu
L	Wilayah Persekutuan Labuan
W	Wilayah Persekutuan Kuala Lumpur

2.6.2 First Geopostcode Part [AAN]: Second Character

District boundary is the second character of geopostcode. Districts are the second largest boundary area after states. There are 10 total numbers of districts in Johor Bahru (Figure 6). Alphabet is the best type of character to represent the second character of geopostcode. It is because the total number of districts is more than nine. When using numeric characters, it will use two characters space in the geopostcode structure algorithm when the number is more than nine. But when using alphabet, only a space is needed in the geopostcode structures; even the total number is more than nine.

Figure 6 Map of districts in Johor Bahru

When the entities boundaries are more than nine, alphabet is the best way to used. The proposed design structure for second character can be seen in the Table 5. As stated in requirement of the geopostcode, the letters 'B', 'I', 'O', 'S', and 'Z' were being eliminated to avoid characters confusion. The districts name was alphabetically sorted first before assign the code character. As Johor Bahru is the capital city, the priority was being given to it by assigning with the first letter which is 'A'. The full codes of all districts in Johor Bahru are shown in Table 5.

Table 5 Second code assigned for each district in study area (Johor Bahru)

Code	District
A	Johor Bahru
C	Batu Pahat
D	Kluang
E	Kota Tinggi
F	Kulaijaya
G	Ledang
H	Mersing
J	Muar
K	Pontian
L	Segamat

2.6.3 First Geopostcode Part [AAN]: Third Character

Third character proposed for geopostcode prototype model structure is the sub-district (Mukim) boundary shown in Figure 7. The data type for this character is a numeric. In Johor Bahru district, there are consist of nine sub-district as listed in the Table 6.

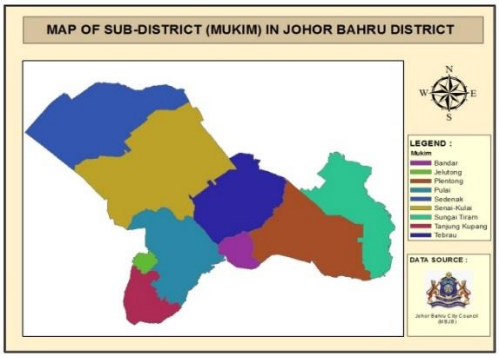


Figure 7 Map of Sub-District in district of Johor Bahru

Table 6 Code assigned for each sub-district in Johor Bahru

Code	Sub-District (Mukim)
1	Bandar
2	Jelutong
3	Plentong
4	Pulai
5	Sedenak
6	Senai-Kulai
7	Sungai Tiram
8	Tanjung Kupang
9	Tebrau

2.6.4 Second Geopostcode Part [NA]: Fourth Character

Administrative boundary is the fourth assigned characters in the geopostcode. Normally, there are less than 10 administrative that manage in a district. In the Johor Bahru district, it only has four administrations that has been displayed in Figure 8 and listed in Table 7.

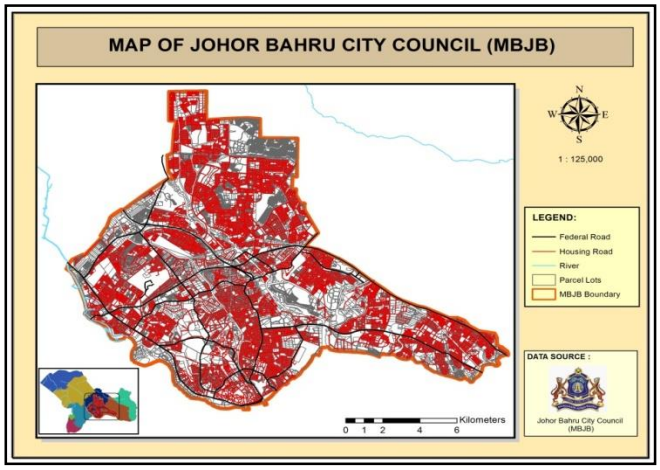


Figure 8 Map of administrative boundary of MBJB

Table 7 Code assigned for each administrative in district of Johor Bahru

Code	Administrative
1	Majlis Bandaraya Johor Bahru (MBJB)
2	Majlis Perbandaran Johor Bahru Tengah (MPJBT)
3	Majlis Perbandaran Kulai (MPKu)
4	Majlis Perbandaran Pasir Gudang (MPPG)

2.6.5 Second Geopostcode Part [NA]: Fifth Character

Overall, Johor Bahru City Council (MBJB) is divided into 16 blocks shown in Figure 9, where each block will be divided into several sub-block (Table 8). This sub-block is called Blok Perancangan Kecil (BPK) and the main function of BPK is for detailing and elaborating on the development and activities for each block. In designing the geopostcode prototype model character, this BPK were used as a reference data layer to increase the consistency and to make sure there is no sharing boundary occurs.

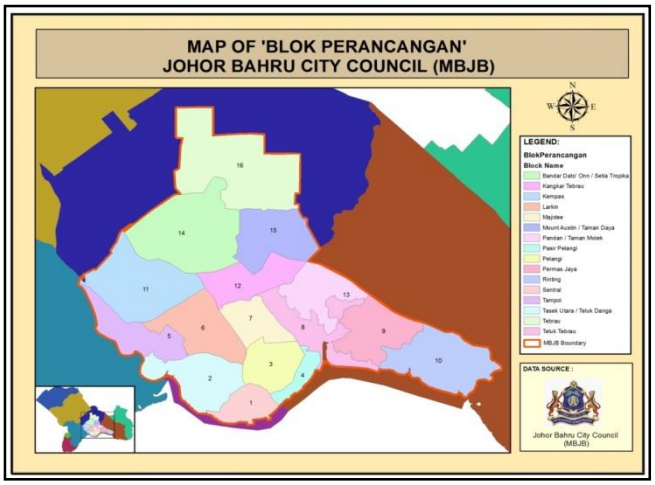


Figure 9 Map of 'Blok Perancangan' MBJB

Table 8 Code assigned for each Block in MBJB administrative boundary

Code	Block No.	Block (Blok Perancangan (BP))
A	BP1	Daerah Sentral
B	BP2	Tasek Utara / Teluk Danga
C	BP3	Pelangi
D	BP4	Pasir Pelangi
E	BP5	Tampoi
F	BP6	Larkin
G	BP7	Majidee
H	BP8	Teluk Tebrau
J	BP9	Permas Jaya
K	BP10	Rinting
L	BP11	Kempas
M	BP12	Kangkar Tebrau
N	BP13	Pandan / Taman Molek
P	BP14	Bandar Dato' Onn / Setia Tropika
Q	BP15	Mount Austin / Taman Daya
R	BP16	Tebrau

2.6.6 Third Geopostcode Part [AAN]: Sixth Character

The sixth character represents residential/housing areas that cover up in a block (Blok Perancangan). The data type chosen for this character is alphabets. It is because most of the Blok Perancangan consists of more than 10 housing area. For example as can be seen in Figure 10, there are 17 housing areas cover up of Blok 2 (Tasek Utara/Taman Daya). So the best choice is the alphabets compare to number. Even the entities are more than 9, only one space needed to assign the character.

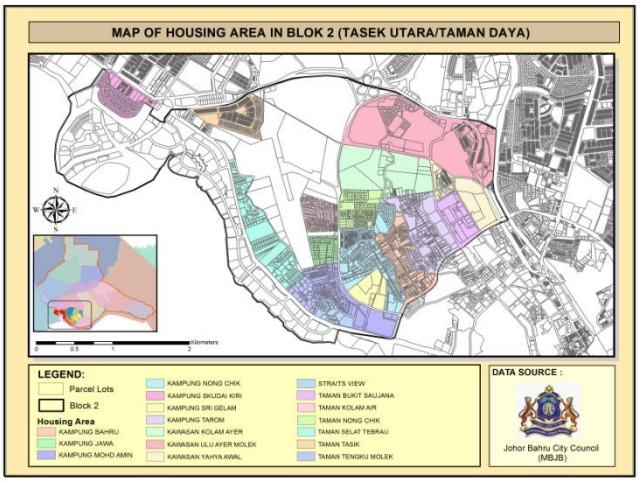


Figure 10 Map of housing area in Block 2

2.6.7 Third Geopostcode Part [AAN]: Seventh and Eight Characters

This is the crucial part in designing geopostcode. In order to increase the level of preciseness, the area coverage must not be too large. As first attempt in model design structure, about 15 parcel lots have been chosen to fill each geopostcode area. After the geopostcode boundaries have been identified, the centroid of the boundaries then can be calculated. Figure 11 shows the goepostcode boundary map of Kampung Skudai Kiri.

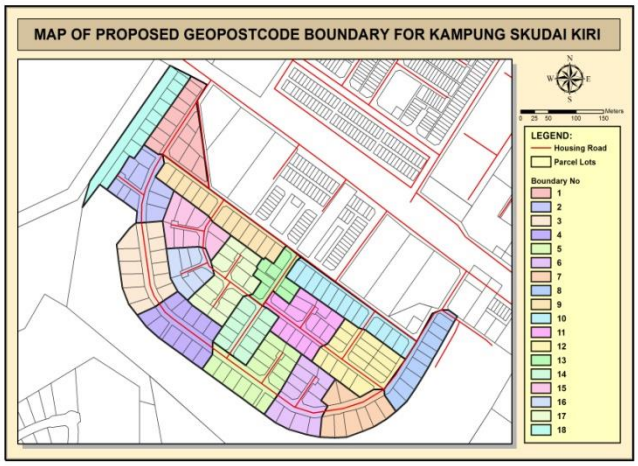
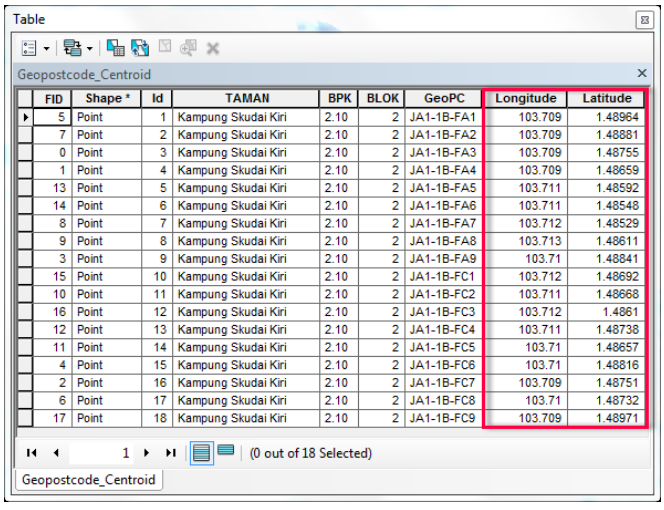


Figure 11 Map of geopostcode boundary at the pilot study area

2.6.8 Centroid Calculation

The centroid of a polygon is the geometric centre of that polygon, calculated using a mathematical algorithm. Polygon centroids are widely used to estimate the 'centre of gravity' of individual polygons in a collection. The main purpose of centroid calculation in this study is to assign the latitude and also longitude at the centroid point. The assigning coordinates of the centroid can be used for navigation purposes. For example in Google Maps, the marker will pinpoint at the centroid of the geopostcode area.

In ArcGIS 10, there are two methods that can be used to calculate the centroid of polygon. First method is by using python programming language and the second method is by using 'Calculate Geometry' function in attribute tables. In this research, the second method has been used because it is easier and doesn't use any programming languages. As can be seen in Figure 12, the coordinates (latitude and longitude) were completely calculated and assigned on each of the geopostcode boundary centroid. The centroid of geopostcode boundary is shown in Figure 13.



Table

Geopostcode_Centroid

FID	Shape *	Id	TAMAN	BPK	BLOK	GeoPC	Longitude	Latitude
5	Point	1	Kampung Skudai Kiri	2.10	2	JA1-1B-FA1	103.709	1.48964
7	Point	2	Kampung Skudai Kiri	2.10	2	JA1-1B-FA2	103.709	1.48881
0	Point	3	Kampung Skudai Kiri	2.10	2	JA1-1B-FA3	103.709	1.48755
1	Point	4	Kampung Skudai Kiri	2.10	2	JA1-1B-FA4	103.709	1.48659
13	Point	5	Kampung Skudai Kiri	2.10	2	JA1-1B-FA5	103.711	1.48592
14	Point	6	Kampung Skudai Kiri	2.10	2	JA1-1B-FA6	103.711	1.48548
8	Point	7	Kampung Skudai Kiri	2.10	2	JA1-1B-FA7	103.712	1.48529
9	Point	8	Kampung Skudai Kiri	2.10	2	JA1-1B-FA8	103.713	1.48611
3	Point	9	Kampung Skudai Kiri	2.10	2	JA1-1B-FA9	103.71	1.48841
15	Point	10	Kampung Skudai Kiri	2.10	2	JA1-1B-FC1	103.712	1.48692
10	Point	11	Kampung Skudai Kiri	2.10	2	JA1-1B-FC2	103.711	1.48668
16	Point	12	Kampung Skudai Kiri	2.10	2	JA1-1B-FC3	103.712	1.4861
12	Point	13	Kampung Skudai Kiri	2.10	2	JA1-1B-FC4	103.711	1.48738
11	Point	14	Kampung Skudai Kiri	2.10	2	JA1-1B-FC5	103.71	1.48657
4	Point	15	Kampung Skudai Kiri	2.10	2	JA1-1B-FC6	103.71	1.48816
2	Point	16	Kampung Skudai Kiri	2.10	2	JA1-1B-FC7	103.709	1.48751
6	Point	17	Kampung Skudai Kiri	2.10	2	JA1-1B-FC8	103.71	1.48732
17	Point	18	Kampung Skudai Kiri	2.10	2	JA1-1B-FC9	103.709	1.48971

(0 out of 18 Selected)

Geopostcode_Centroid

Figure 12 Latitude and longitude calculated for geopostcode

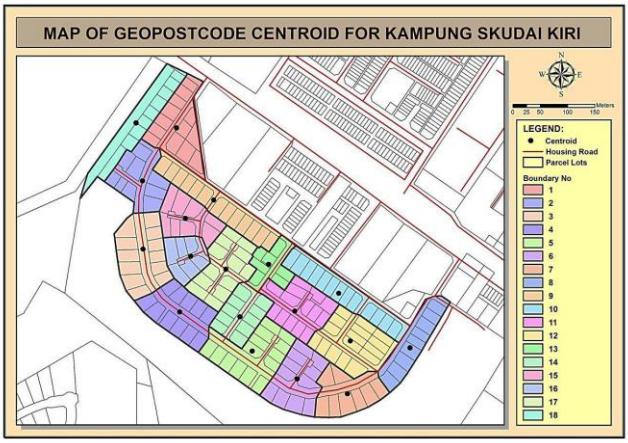


Figure 13 Map of geopostcode centroid for study area (Kampung Skudai Kiri

■3.0 RESULTS AND DISCUSSION

Based on the characters requirement that has been discussed, here is the result of the geopostcode for the pilot study area, which is Kampung Skudai Kiri. The algorithm of geopostcode structure was assigned for this area is using AAN-NA-AAN format and based in Table 9.

Table 9 Specification data layer for pilot study area (Kampung Skudai Kiri)

Data Layer	Pilot Study Area
Housing Area	Kampung Skudai Kiri
Block	Tasek Utara/Teluk Danga
Administrative	MBJB
Sub-district	Bandar
District	Johor Bahru
State	Johor

3.1 Results for Assigning the Alphanumeric Code for Study Area

The first character of the geopostcode is based on the unique vehicle registration plate number of each state in Malaysia. Based on the study area, which is in the state of Johor; the first code character is the letter '**J**' that is highlighted in Table 10.

Table 10 Assigning for initial character of geopostcode

Code	State
A	Perak
B	Selangor
C	Pahang
D	Kelantan
J	Johor
K	Kedah
M	Melaka
N	Negeri Sembilan
P	Pulau Pinang
Q	Sarawak
R	Perlis
S	Sabah
T	Terengganu
L	Wilayah Persekutuan Labuan
W	Wilayah Persekutuan Kuala Lumpur

For the second character, district boundary layer was used as a base layer that is assigned by the alphabets. The study area of Skudai Kiri is located in the district of Johor Bahru. So the second character given for the geopostcode is the letter 'A' as shown in Table 11.

Table 11 Combination two characters of geopostcode by adding district assigned code

Code	District
JA	Johor Bahru
JC	Batu Pahat
JD	Kluang
JE	Kota Tinggi
JF	Kulaijaya
JG	Ledang
JH	Mersing
JJ	Muar
JK	Pontian
JL	Segamat

For the third character, sub-district boundary layer was used as a base layer that is assigned by the numeric character. As for Kampung Skudai Kiri, it is located in the district of Bandar, therefore, the third character specified for the geopostcode is the code **JA1**, as shown in Table 12.

Table 12 Combination of three characters of geopostcode by adding sub-district assigned code

Code	Sub-District (Mukim)
JA1	Bandar
JA2	Jelutong
JA3	Plentong
JA4	Pulai
JA5	Sedenak
JA6	Senai-Kulai
JA7	Sungai Tiram
JA8	Tanjung Kupang
JA9	Tebrau

Meanwhile, the administrative boundary is the fourth assigned characters in the geopostcode and it is set by a numeric character. The Kampung Skudai Kiri is in the MBJB administration boundary. Then, the character specified is the number 1. The combination of geopostcode characters are shown in the Table 13.

Table 13 Combination of four character of geopostcode by adding administrative assigned code

Code	Administrative
JA1-1	Majlis Bandaraya Johor Bahru (MBJB)
JA1-2	Majlis Perbandaran Johor Bahru Tengah (MPJBT)
JA1-3	Majlis Perbandaran Kulai (MPKu)
JA1-4	Majlis Perbandaran Pasir Gudang (MPPG)

For the fifth character, block boundary layer (Blok Perancangan (BP)) was used as a base layer that is assigned by an alphabet character and Kampung Skudai Kiri is located in the BP2. So the fifth character specified for the geopostcode is the letter '**C**' and the combination of five characters geopostcode is shown in the Table 14.

Table 14 Combination of five character of geopostcode by adding block assigned code

Code	Block No.	Block (Blok Perancangan (BP))
JA1-1A	BP1	Daerah Sentral
JA1-1C	BP2	Tasek Utara / Teluk Danga
JA1-1D	BP3	Pelangi
JA1-1E	BP4	Pasir Pelangi
JA1-1F	BP5	Tampoi
JA1-1G	BP6	Larkin
JA1-1H	BP7	Majidee
JA1-1J	BP8	Teluk Tebrau
JA1-1K	BP9	Permas Jaya
JA1-1L	BP10	Rinting
JA1-1M	BP11	Kempas
JA1-1N	BP12	Kangkar Tebrau
JA1-1P	BP13	Pandan / Taman Molek
JA1-1Q	BP14	Bandar Dato' Onn / Setia Tropika
JA1-1R	BP15	Mount Austin / Taman Daya
JA1-1T	BP16	Tebrau

Finally, the sixth character represents residential/housing areas that cover up in a block (Blok Perancangan). The data type set for this character is alphabets. There are 16 housing areas cover up of Blok 2 (Tasek Utara/Taman Daya) that sorts alphabetically. The code specified for Kampung Skudai Kiri is the letter '**F**'. The combination of the six characters can be seen in Table 15.

Table 15 Combination of six character of geopostcode by adding housing area assigned code

Geopostcode	Housing Area
JA1-1C-A	Kampung Bahru
JA1-1C-C	Kampung Jawa
JA1-1C-D	Kampung Mohd Amin
JA1-1E-E	Kampung Nong Chik
JA1-1C-F	Kampung Skudai Kiri
JA1-1C-G	Kampung Sri Gelam
JA1-1C-H	Kampung Tarom
JA1-1C-J	Kawasan Kolam Ayer
JA1-1C-K	Kawasan Ulu Ayer Molek
JA1-1C-L	Kawasan Yahya Awal
JA1-1C-M	Straits View
JA1-1C-N	Taman Bukit Saujana
JA1-1C-P	Taman Kolam Air
JA1-1C-Q	Taman Nong Chik
JA1-1C-R	Taman Selat Tebrau
JA1-1C-T	Taman Tasik
JA1-1C-U	Taman Tengku Molek

After combining from all the eight characters based on the hierarchical boundaries of data layers, the complete eight alphanumeric geopostcode were produced. The complete geopostcode character assigned for all parcel lots in Kampung Skudai Kiri are shown in Table 16.

Table 16 Complete eight characters of geopostcode by adding the parcel/geopostcode boundary code

Geopostcode	Geopostcode Boundary No.
JA1-1C-FA1	1
JA1-1C-FA2	2
JA1-1C-FA3	3
JA1-1C-FA4	4
JA1-1C-FA5	5
JA1-1C-FA6	6
JA1-1C-FA7	7
JA1-1C-FA8	8
JA1-1C-FA9	9
JA1-1C-FC1	10
JA1-1C-FC2	11
JA1-1C-FC3	12
JA1-1C-FC4	13
JA1-1C-FC5	14
JA1-1C-FC6	15
JA1-1C-FC7	16
JA1-1C-FC8	17
JA1-1C-FC9	18

3.2 Map Visualization of Geopostcode

The boundary map for each of the 18 boundaries assigned with geopostcode for Kampung Skudai Kiri is illustrated such in Figure 14. From the map in that figure, it can be seen that each of the geopostcode boundaries cover a very small area that is within average of 15 parcel lots, which make this geopostcode very precise for addressing and also for navigation purposes.

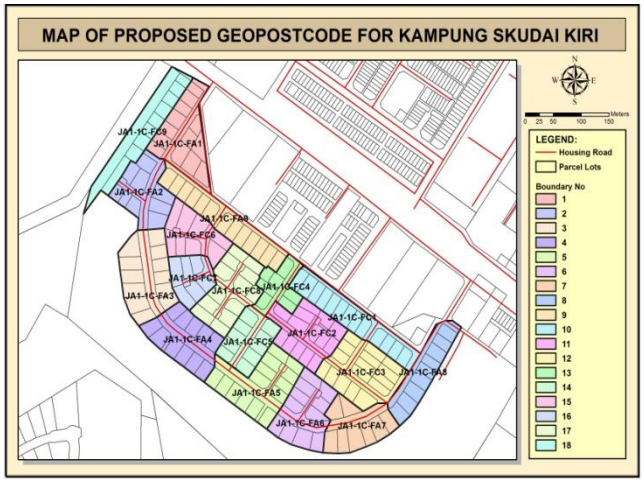


Figure 14 Map of proposed alphanumeric geopostcode

3.3 Recommendations for Future Implementation of Geopostcode Framework in Malaysia

From this initial development, there are some aspects that can be enhanced for future improvements and implementations to get a better result and to reduce some gaps that can makes this geopostcode works perfectly in Malaysia.

The total number of parcel lots used in this study is set up to 15 since it is the suitable area size for residential area to be created and not too big or too small. The other aspect that should be explored in the geopostcode design is the privacy of the property owners; until to what level the geopostcode data will expose their property location.

At the first stage of the geopostcode framework development, the study area just only for a housing area in MBJB. For future developments, the study area should be extended and the geodatabase is not only on a housing area in MBJB but also in other administrative boundaries.

Reserved geopostcode also should be developed for place of interest (POI) especially for tourism purpose. For examples, Kuala Lumpur City Centre (KLCC), Reserved Forest, Legoland, National Mosque and many more.

This geopostcode hopefully can be designed and assigned for squatter area and unorganized housing area especially in village and rural area so that it can widely use in Malaysia.

4.0 CONCLUSION

Based on the result, it can be summarized that geopostcode produce better precision, reliable, and memorable compare to existing postcode. The short and clear characters that avoiding characters confusion make it more users friendly. Using a geopostcode enables peoples to achieve very high positional precision, much greater than an area based code such as a postcode or ZIP code. This is really useful when the major function of this geopostcode is to uniquely identify a location so that it can be physically visited in the real world or virtually visited on a digital map.

Acknowledgement

The authors would like to thank and acknowledge the Universiti Teknologi Malaysia (UTM) and Ministry of Higher Education of Malaysia for their financial supports on the research grant Vot Number Q.J130000.2527.08H85.

References

[1] Universal Postal Union (UPU). 2010. *Formatting an International Address*. 13: 105.
[2] Mohd Zaidi, A. K. 2012. *Postcode - Power in Numbers*. Pos Malaysia.
[3] Smith, S. 2005. *Demography and Methodology Branch*. 25: 238.
[4] West Virginia State-wide Addressing and Mapping Board. 2004. *West Virginia 9-1-1 addressing handbook, Vol. II.*
[5] Walker, R. 2004. *Project Acacia - Addressing requirements study.* (Web link: http://www.ros.gov.uk/pdfs/acacia_require_study_may04.pdf.
[6] CODI-Geo/DISD. 2005. *Background Working Document for the Ad Hoc Expert Group Meeting on Geographic Data as a National Asset: Focus on Situs Addressing*.
[7] Jorcine, P. 2012. *Geocoding and Reverse Geocoding Applications.* Case Studies of Implementation in Malaysia for Municipalities and Real Estate Agencies.
[8] Pierre R. 2004. *Postcode System Review Project–Preliminary Investigation and Proposed Way Forward.*
[9] Pierre R. 2005. *Postcode Renewal Project–Proposed New Postcode System.*
[10] The Charles Close Society. 2011. Loc8 Codes–Directions Made Easy. *Gary Delaney Sheetlines*. 9(8): 40.
[11] National Academy of Public Administration (NAPA). 1998. *Geographic Information for the 21st Century–Building a Strategy for the Nation*. Washington, D.C.: National Academy of Public Administration.