

# Measuring the Magnetic Impact of Economic Agglomeration for Industrial and Business Environment through Spatial Mapping.

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**Abstract.** Smart City concept is known for years and it always relate with the use of smart technologies as it could manage energy efficiently. However, what if there is a way in managing energy efficiently without fully relying on smart technologies which are quite expensive. If we look in a bigger context, a proper management of land use and spatial information could also change the amount of energy used and ensure the maximum allocation of resources efficiently. This research will examine the agglomeration of industrial and business environment within Pengerang District through GIS spatial analysis. Hot Spot analysis were used in giving a visual representation of agglomeration for a better understanding on what is happening in Pengerang District. Findings shows that industrial and businesses are clustering at Bandar Penawar and Pengerang. The industrial sector includes classes mainly of mining and quarrying, manufacturing, and warehouse industry. While analysis on business sector indicate higher number of wholesale and retail, services, and accommodation. The clustering pattern of all of the mentioned class were also identified.

**Keyword:** Economic Agglomeration, Agglomeration Pattern, Industrial and Business

## 1. Introduction

Smart City is one of the recent attracting concepts in the industry, which the method of managing spatial information has become a hot research topic. Therefore, this research will try to provide spatial visualization of the industrial area with GIS technology within the case study area. Spatial analysis, spatial statistic and complexity modelling will be used as tools in order to integrate management facilities and highlight the industrial and business activity in the study area. This research will help to evaluate the qualitative and quantitative judgement of property places and its relationship with surrounding development or neighbourhood.

## 2. Agglomeration of Industrial and Business

Agglomeration alone are defined as a large group of many different things collected or brought together. But in terms of economy, agglomeration can be seen as a clustering of economic activities such as industries, businesses, and services. Within the same context, agglomeration economies are referred as benefits obtained from concentrating output and housing in particular areas. Xiao-lu et.al



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[1] highlighted urbanization agglomeration as the clustering of cities with a finite spatial scope, meaning that it consists of unified natural environment and social aspect, huge population and economy, advanced level of urbanisation and industrialisation, and excellent infrastructure amenities. Tripathi [2] explained new economic geography consist of a collective equilibrium framework with disfigured rivalry. He also mentioned that the essence acceptance of new economic geography were product differentiations in a way that it is designed with a diverse expectation, it is able to strengthen the returns to scale of the industry and having the cutback on transportation costs.

The reason for these clustering of activities was already been studied by various economist since 90's. Marshall [3] observed that there are three factors influences the clustering of firms in an area; transportation costs of goods between suppliers and customers, attraction power of people and labours with skills on clustering area, and technological knowledge spillovers mainly in the form of sharing or exchanging of ideas between firms. This can be further supported by Puga and Venables [4] where they mentioned that relationship between limited competency, transportation costs, and input-out structure shape the pattern of accumulation of firms and industry to be located near with suppliers and customers. On the other hand, Guimaraes et.al [5] explained that there are two factors of externalities involved in agglomeration, which are the proportion of industry or firm located in a particular site, and the type of service accommodated. These two externalities were proven to attract industries and firms in an area which lead to localization of economic and increases the productivity. However, Hafner [6] argued that the factor of shifting towards urban area from rural area has a strong relationship with the forming of agglomeration. And it can be concluded that sectoral migration influences the pattern of firm location, while the interregional migration influences the planning of country. Boudier-Bensebaa [7] highlighted that benefit acquired from accommodated infrastructure are a cause for agglomeration. Picard and Zeng [8] also concluded that the agricultural sector is important in determining the spatial configuration of economic activity, especially among the developing countries. Furthermore, Tripathi [2] analysed the agglomeration of industry and it came out based on five aspects which are output, labour, private capital, social overhead capital, and materials. Lastly, Howard et.al [9] explained that the causes of agglomeration economies in developing countries is through entrepreneur that have many workers equipped with inadequate standard of education and lack of expertise.

Although the factors of agglomeration were identified, measuring it was challenging. Various methods were proposed in order to measure and analyse its pattern and concentration. One of the methods was from Tomoya and Smith [10] that did an improvement by proposing a pattern type based on cluster detection procedure to measure the global extent and local density of agglomeration pattern. This improvement aids in strengthening concepts involving agglomeration such as the spatial dispersion of manufacturing on levels of transportation costs. On the other hand, Ellison and Glaeser [11] constructed the EG index that helps in measuring the coagglomeration between two industries. The index highlights the needs of data such as the size of industry, and the employment share in order to analyse the components that lead to the clustering of industry and related with urbanisation. However, Howard et.al [9] argued that the EG index of coagglomeration cannot be applied on developing countries due to its fixate on workers as the cause of agglomeration economies as the results would not identify the agglomeration economies in clustering of small sized firms. They also argued the EG index controls for urbanization. The reason where it correlates the employment share with the mean employment share of the given zone, meaning it restraint the population density of the zone whereas it should consider the overall population distribution. This method would cause the EG index to overweight clustering of firms in rural areas. Therefore, the best way of measuring the degree of agglomeration is by concentrating on entrepreneur or firms. Thus, they proposed excess colocation (XCL) index in overcoming the weakness of EG index, through concentrating on individual firms, not the workers, as the cause of agglomeration economies.

Listed below are among the researches that have been done regarding the topic of agglomeration of economy in certain countries. Guimaraes et.al [5] examined the economies in Portugal and results shows that service agglomeration economies are in first rank, coming with localization economies when compared to their agglomeration effect. Then, Cohen and Paul [12] examine the cost economies

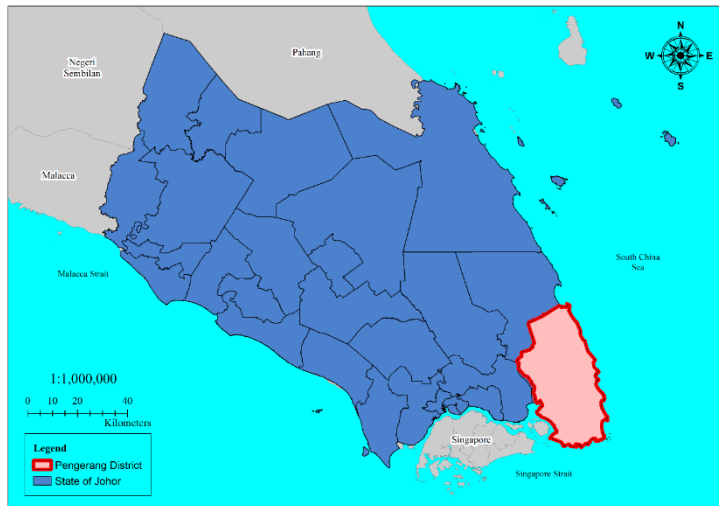
of food manufacturing industries in the United State which resulted in as the crucial motivations in terms of location decisions for agglomeration. Moreover, Fan and Scott [13] overviewed the economic development of developing country in East Asia like China. Their finding suggests that there is a positive connection of industrial clustering and the industry's productivity where in China especially can be seen on industry that manufacture computers and electronics. Next, Boudier-Bensebaa [7] did a research on examining the relevance of agglomeration effects on the basis for foreign direct investment in Hungary. Results shows that countries with greater jobs opportunity, industrial demand, and manufacturing activity can captivate higher foreign direct investment to their area. Tripathi [2] also did a research in determining whether industries and firms in India are performing or not based on their returns to scale using the Kanemoto et al. (1996) model. The findings however are not promising as those industries and firms are actually operating under declining return to scale. Then Howard et.al [9] found out that the trading in developing counties are more to segregated pattern, the cost implemented from production are minor, and entrepreneur are less technologically advanced. Lastly, Gokan et.al [14] did a research to determine the significance of agglomeration economies on productivity in Vietnam referring to firm-level through the method of cluster detection. Findings shows that localization economies do increases the productivity on firm-level especially when they are aggregated together in an area and only foreign-owned firms benefit from urbanization economies in terms of productivity instead of state-owned and private firms, thus was concluded that the agglomeration economies of urbanization economies in Vietnam are not quite potent

As the technology development keep on advancing, the use of geographic information system application was also accepted by various professions in measuring and analysing the pattern of agglomeration. However, not much researches were available. One of the reasons were the lack of data and spatial information that was needed for the use of geographic information system application. Nonetheless, the use of Gini and Moran's I coefficients were quite common among researches. However, Ying et.al [15] argued that Gini coefficients overlook the spatial data, which lead to a-spatial estimation. Thus, they tried to apply spatial autocorrelation analysis to measure the urbanization and localization economies in Jiangsu Province between year 1999 to 2002 based on the secondary and tertiary industry and results obtained were logical and equivalent with the economic condition during those year, as the localization economies of secondary industry were dominant around the southern part and middle part of Jiangsu. While for tertiary industry, it has a distinct urbanized economy around centres of social and economies activities and urban districts especially at the north-eastern part of Jiangsu where the industry gain interest out of massive market as well as he advanced services. Guillain and Gallo [16] also did a research on analysing the agglomeration of industry in Paris consisting of the sector of manufacture and services through the method of locational Gini and Moran's I coefficients, Moran scatterplots, and LISA statistics. Findings shows that the shape of agglomeration observed were directed toward service sectors as the final chain of demand were the population itself. As for the Moran scatterplot, majority of the sectors are indicated as positive spatial association. Three (3) main agglomerated sectors were focussed as their agglomeration patterns are distinctive based on their location, forms, and environment. Sector for Coking, petroleum refining and nuclear industry are closely related with the existence of natural resources. Sector for construction seems to be based on allocation of population, and sector of finance-insurance were focussing on businesses-oriented area. Lu and Cao [17] tried to analyse the agglomeration pattern of big data industry in China as well as determining the components in further improving this industry through the use of spatial analysis and GIS technology involving kernel density analysis, global Moran's I, LISA clusters, and spatial lag/error models. The identified components related with agglomeration of big data industry were the accumulation and amount of universities, government financial budget for science, population, and the gross domestic product of cities. Based on the four (4) mentioned components, financial budget and the accumulation of universities were the only positive aspect that causes the agglomeration of big data industry. Findings also shows that the agglomeration pattern and spillover were weak and it only happen in cities where the provinces are still developing, with reason that the big data industry are still in primary stage of development.

### 3. Research Methodology

#### 3.1. Study Area

Pengerang district is located at the south-eastern part of Johor, under the bigger district of Kota Tinggi and administration of Pengerang Local Authority (PBT Pengerang). **Figure 1** below shows the location of Pengerang District from the regional context of Johor. Pengerang District consist of 3 town located on northern part, middle eastern part, and southern part of it, which are Sedili Kechil, Bandar Penawar, and Pengerang respectively (refer to **Figure 2**).



**Figure 1.** Location of Pengerang District on Johor's context.



**Figure 2.** Map of Pengerang District.

Referring to *Draf Rancangan Tempatan PBT Pengerang 2018-2030* [18], it is to be noted that only about 4,180.15 hectare (3.38%) of total land area are classified under the zoning of industrial, while about 2,065.45 hectare (1.67%) are classified as commercial uses. However, Pengerang is known for its mega project and rapid industrial development involving oil and gases. Pengerang Integrated Petroleum Complex (PIPC) was proposed to maximise the resources available and bring benefits to the locals and the country itself therefore significant changes of economic and land uses are happening in Pengerang throughout the year.

#### 3.2. Average Nearest Neighbour (Spatial Statistics)

Average Nearest Neighbour analysis is crucial in determining the significance of data for further analysis whether it is a clustered, dispersed, or a random pattern. The way this analysis determines the pattern of feature is through the calculation of average interval and mean interval between features' centre point.

Based on existing data which are land use form of Pengerang District in year 2015, and the location of companies and businesses obtained from Companies Commission of Malaysia (*Syarikat Suruhanjaya Malaysia*, in short SSM), the analysis of Average Nearest Neighbour shows that the z-score resulted with -61.31 meaning that the data shows clustered pattern and there is a less than 1% likelihood it resulted of random chance.

#### 3.3. Hot Spot Analysis (Getis-Ord $G_i^*$ )

This analysis measures the Getis-Ord  $G_i^*$  statistic from the selected feature as the z-scores and p-values of it would then be used to identify whether it is highly or lowly clustered together. Hot Spot analysis is suitable in determining and showcase where and how clustered the selected feature are.

Data of industrial and businesses within Pengerang District were joined with grid polygons of fishnet that have the size of 500 x 500, which resulted in the accumulation of total number of features within each grid polygons. These grid polygons fishnet would then measure using Hot Spot analysis to showcase which area the clustering form and how dense are the clustering of selected feature.

#### 4. Research Analysis and Findings

##### 4.1. Hot Spot Analysis based on Land Use

The land use data of Pengerang District that were used in this analysis dated in year 2015, which means that the source is a bit outdated especially on industrial sectors. It is important to highlight that this is the year where mega projects and industrial development such as PIPC were just starting, and after years gone by, surely the number of industrial companies increases drastically. With the rapid development of industrial sector within Pengerang District, town like Bandar Penawar received huge influential spillover as the town itself turns into a centre of businesses and administration among the community.

*4.1.1. Industrial and Businesses.* Industries and businesses are related with each other as their location determine the costs involved. Studies shows that industries and businesses tend to be built close with each other to minimise costs involved such as transport and resources. Based on **Figure 3**, Hot Spot analysis on industrial and businesses based on land use data of Pengerang District shows that they are highly clustered together at Bandar Penawar and Pengerang.

*4.1.2. Industrial.* Industrial play an important role in Pengerang as the district itself focus this sector in thriving its economy. PIPC is among the major industrial project implemented at Pengerang and it consist of heavy industries that relates with petroleum and natural gases. However, the outdated and lack of data on land use of Pengerang District could not highlight these clustering of heavy industries at Pengerang. Nonetheless, industrial land use within Pengerang District are clustering at Bandar Penawar and Pengerang (**Figure 4**). It also indicates that industrial there consists mainly the class of mining and quarrying which clustering around Pengerang and nearby to Tekong Island (**Figure 5**), following with manufacturing which the clustering is scattered near main road (**Figure 6**), and warehouse class industry that clustering near Bandar Penawar (**Figure 7**).

*4.1.3. Businesses.* In term of businesses or commercial land use, overall the clustering of it can be seen scattering around Pengerang District which correlate with location of residential area. Interestingly, clustering pattern are seen mainly at Bandar Penawar as Bandar Penawar is considered as the main town of Pengerang District in term of businesses and administration (**Figure 8**). Data of commercial land use also indicate that the class of wholesale and retail have the highest number of unit and its clustering pattern scatter near the main road which suggest it is near to residential area (**Figure 9**). Services class recorded as the second highest number of unit and its clustering pattern can be seen concentrated at Bandar Penawar which proven as the main area for administration and businesses (**Figure 10**). Moreover, accommodation class are concentrated near Pengerang and coastal area as it suggests that the businesses are targeting workers from Pengerang and tourists that came for leisure purposes (**Figure 11**).

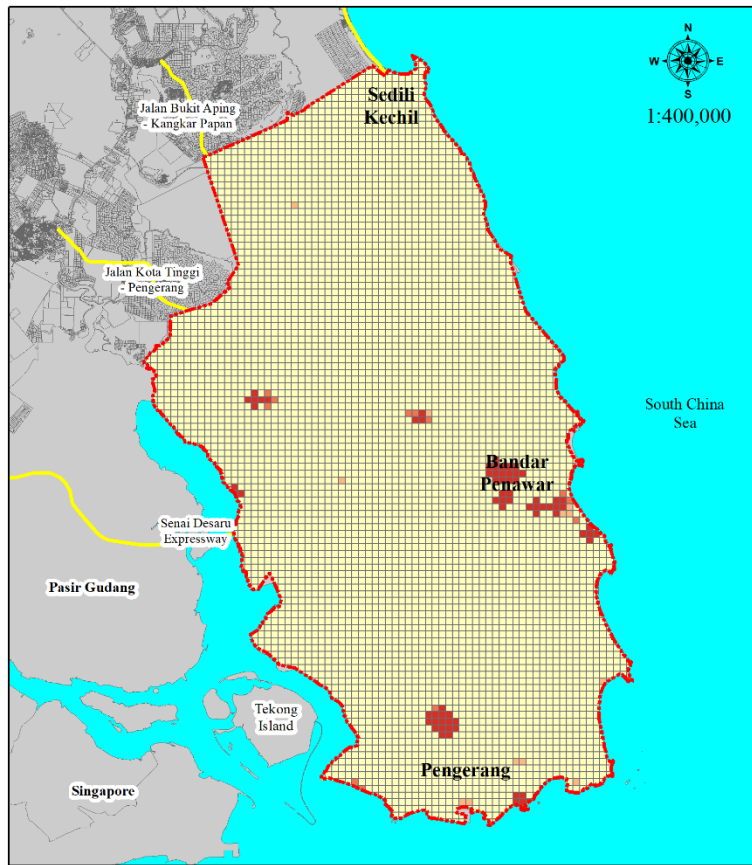


Figure 3. Hot Spot analysis of industrial and businesses at Pengerang District.

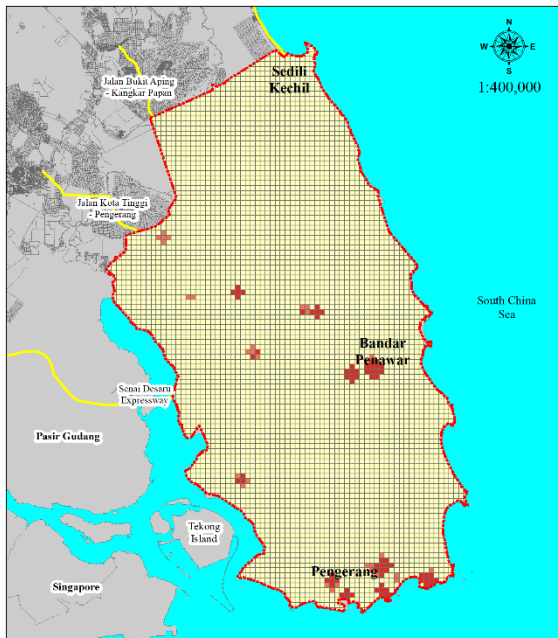


Figure 4. Hot Spot analysis on industrial sector in Pengerang District.

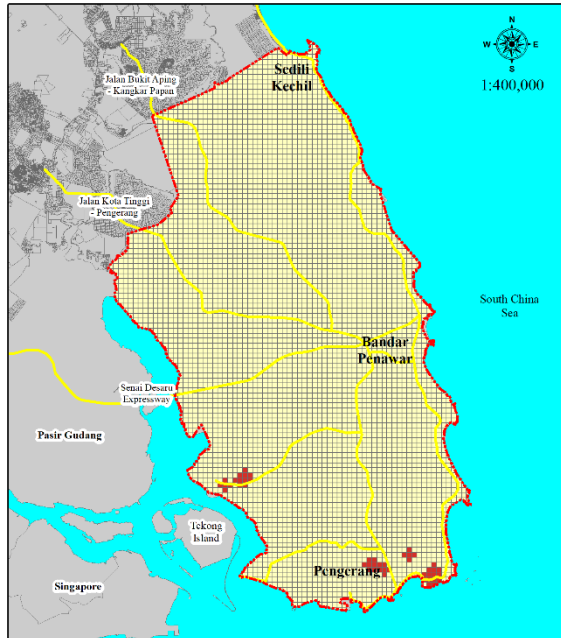


Figure 5. Hot Spot analysis on mining and quarrying class in Pengerang District.

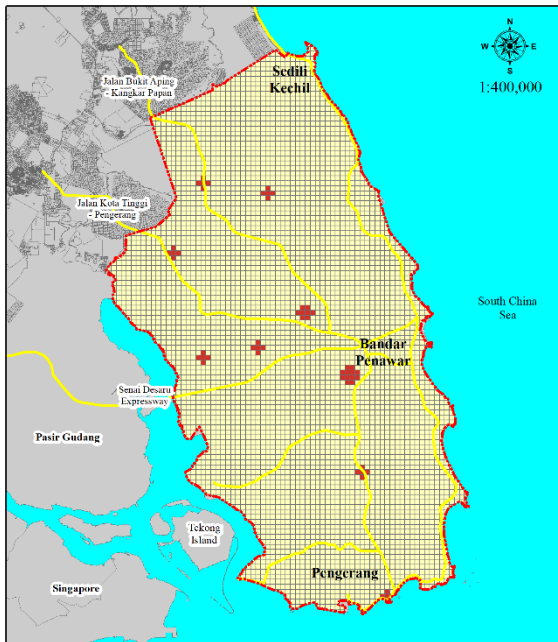


Figure 6. Hot Spot analysis on manufacturing class in Pengerang District.

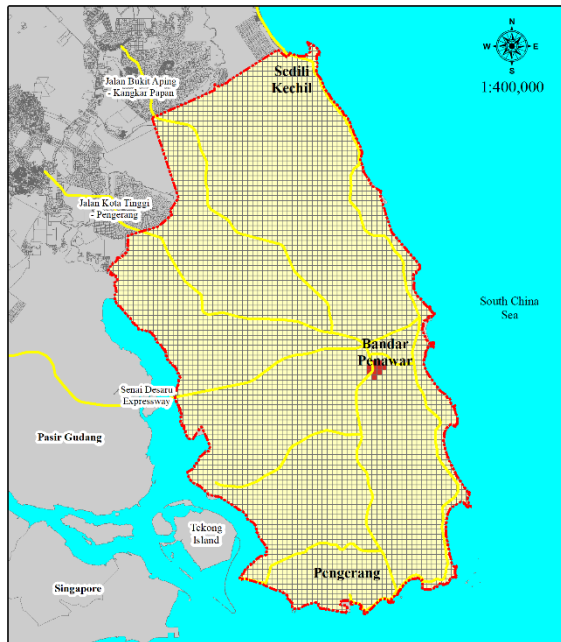


Figure 7. Hot Spot analysis on warehouse class in Pengerang District.

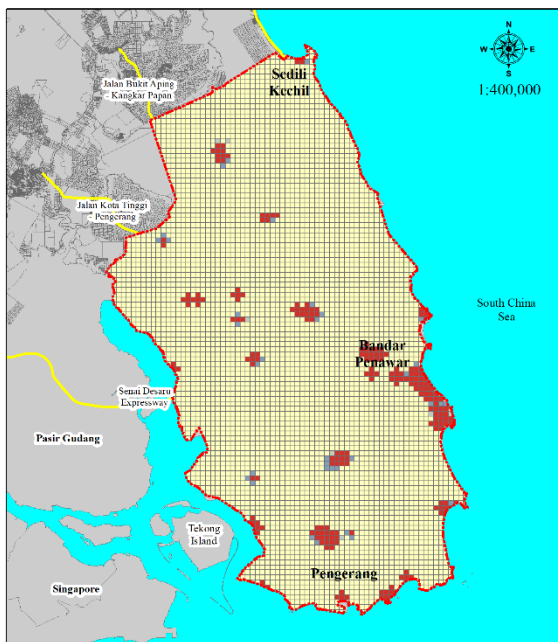


Figure 8. Hot Spot analysis on businesses sector in Pengerang District.

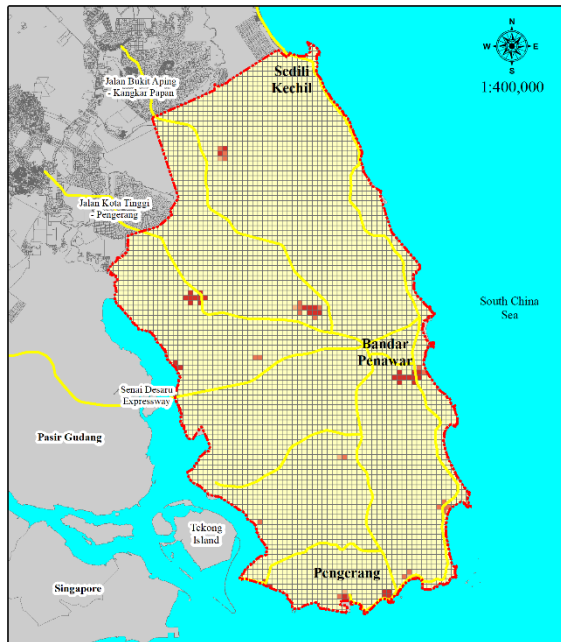
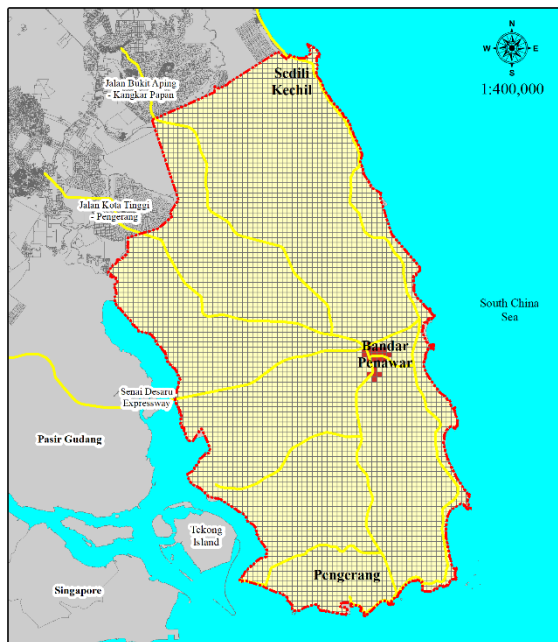
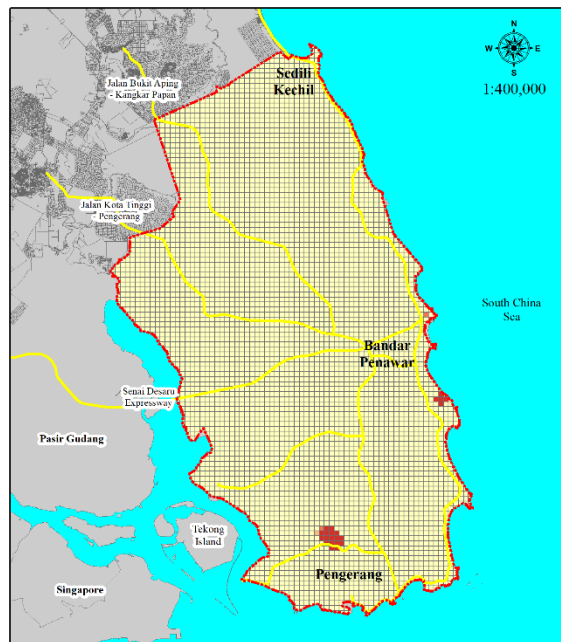


Figure 9. Hot Spot analysis on wholesale and retail class in Pengerang District.



**Figure 10.** Hot Spot analysis on services class in Pengerang District.



**Figure 11.** Hot Spot analysis on accommodation class in Pengerang District.

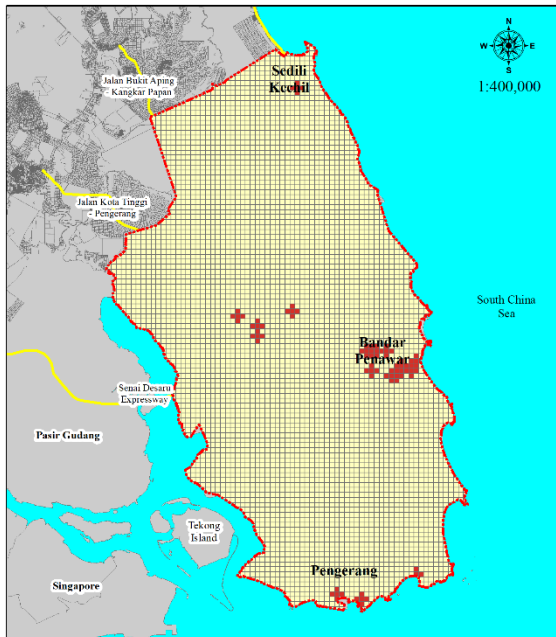
#### 4.2. Hot Spot Analysis (Registered Companies).

Hot Spot analysis were used on list of registered companies and businesses obtained from SSM Johor. The data consist of the company's name, address, type of business, and value of asset. However, owner of company was not obligated to give their business address and their company's asset value, causing the difficulty in digitizing the data in spatial or map form. Another constrains observed were most of the data were irrelevant as it was located out of the boundary of Pengerang District. This is due to the fact that Pengerang District was under the district of Kota Tinggi few years back, meaning it was under the local authority of Kota Tinggi, Majlis Daerah Kota Tinggi (MDKT) instead of current local authority of Pengerang District, PBT Pengerang. From 157 companies listed, only 25 companies were located within Pengerang District. Nonetheless, analysis can still be done to examine the clustering patter of companies and its asset value.

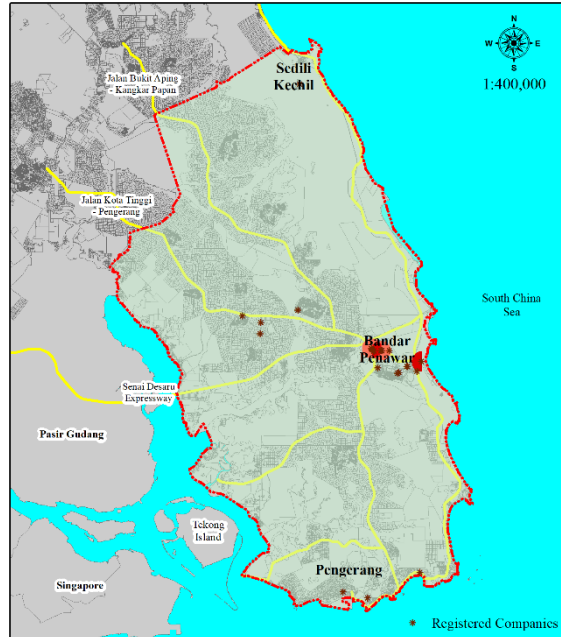
Based on **Figure 12**, the clustering pattern of companies can be seen concentrated at Bandar Penawar. This is relatable to the analysis being done on land use data of Pengerang District where high clustering of industrial and businesses are also located at Bandar Penawar, due to its function as the main town of Pengerang District. Another fact is that the classes of construction, plus wholesale and retail shows dominance among the companies listed.

**Figure 13** referring to density of asset value among companies listed. The darker the tone of colour, the higher the value of asset. The concentration of density can be seen only at Bandar Penawar which suggest that it is the location where value of property is the highest among other town and places within Pengerang District. The highest asset value per company which has the darker tone is located beside Bandar Penawar, and the company is known as Lotus Desaru Beach Resort & Spa. It is located at Desaru, famous coastal area and known in providing luxury accommodation and recreational activities to tourists.





**Figure 12.** Hot Spot analysis on registered companies in Pengerang District.



**Figure 13.** Density analysis on asset value of companies in Pengerang District.

## 5. Discussion

This research tried to identify the agglomeration of industrial and businesses within Pengerang District. Two type of data were analysed in determining the agglomeration pattern, which are the land use data of Pengerang District from year 2015 and list of registered companies within Pengerang District. In terms of land use data, the type of land use was separated between industrial and commercial (businesses) sector for further analysis and get a more detail explanation on the clustering pattern. Overall industrial sector can be seen clustering at Bandar Penawar and Pengerang, but separation of classes of industry indicates that mining and quarrying are clustering at Pengerang, while manufacturing are scattering near main road, and warehouse industry are clustering at Bandar Penawar. On the aspect of businesses, clustering pattern are distinguishable as it mainly located at Bandar Penawar. Three main classes of business in Pengerang District were identified and it is noticeable that the clustering pattern of wholesale and retail are scattered near main road, services class however shows a concentrated clustering at Bandar Penawar, while accommodation class noted to clustered at Pengerang and beside Bandar Penawar which is near to coastal area. Overall, when considering both industrial and businesses, the clustering are visibly seen located at Bandar Penawar and Pengerang as both locations are considered as the main town of Pengerang District and site of huge industrial development respectively.

On the other hand, data regarding registered companies in Pengerang District which were obtained from SSM Johor indicated the clustering are located at Bandar Penawar. Analysis on asset value also indicate there is a higher value of property in Bandar Penawar compared to another town in Pengerang District. However, the analysis done might be insignificant as there are too little data obtained. Transparency of data and information regarding registered companies are almost impossible as there were no rules or obligation for companies in submitting their company's info. Even so, most of the data obtained were not up-to-date and full of inconsistency. As the industrial revolution 4.0 were implemented, government should start focussing on big data around the countries as digital information are crucial for current age of technologies.

Nonetheless, both aspect of agglomeration pattern based on land use and list of registered companies above would help in future planning of industrial and businesses sector of Pengerang

District. The type of industrial businesses and its location are crucial for determining which classes of industrial businesses sector should be located near and integrate with each other. It could benefit the use of land and costs involved regarding near to resources and product supply chain.

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