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Analysing Spatial Pattern of the Three Major Fast-Food Chain Restaurants in Johor Bahru Johor, Malaysia

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Abstract **–** Spatial analysis has proven to be an impactful tool in business for gaining insights and making informed decisions, especially in analysing spatial patterns and finding new locations for starting or expanding the business. However, most fast-food chain restaurants have t yet to optimise the use of GIS, especially in analysing the spatial distribution patterns of their outlets. This study aims to analyse the spatial distribution patterns of three major fast-food chains in Johor Bahru, Malaysia: KFC, McDonald's, and Burger King. Four spatial analyses were performed: network analysis, buffer analysis, heatmap analysis, and spatial distribution pattern analysis using the nearest neighbour technique. The results showed different spatial distribution patterns for these three major fast-food chains. KFC is more spatially randomly distributed, concentrated in downtown Johor Bahru, while McDonald's is spatially scattered throughout the Johor Bahru district and the Skudai area. Burger King has too few outlets and is spatially scattered in the Johor Bahru district. From these results, fast-food franchises can use the information to locate new locations based on their indicators for new outlets.

Keywords *– Fast-food chain, Hotspot analysis, Network analysis, Spatial analysis, Spatial distribution, Spatial pattern*

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1.0 Introduction

Spatial analysis in Geographic Information Systems (GIS) has proven to be a powerful tool for businesses to gain insights and make informed decisions (Church & Murray, 2009). GIS is a system for collecting, storing, managing, processing, analysing, and producing output on data that references real-world locations (Burrough et al., 2015). GIS enables businesses to collect, process, store, manage, and analyse various aspects of a business, including customer behaviours, market trends, and resource allocation (Roig-Tierno et al., 2013).

Besides that, GIS can help businesses find new prospect locations, manage logistics, site and facilities management, marketing, decision-making, and planning (Azaz, 2011). By integrating GIS into their operations, companies and businesses can better understand their targeted customers, optimise their operations, shut down any underperforming premises, and improve their overall performance (Azaz, 2011; Church & Murray, 2009).

One key application of GIS and spatial analysis in business is location intelligence. For example, identify potential markets, understand customer needs and preferences, and target their marketing effort more effectively (Bopche & Neware, 2020). The spatial analysis also enables optimising supply chain and logistics operations, analysing transport routes, or optimising resource allocation (Roig-Tierno et al., 2013; Azaz, 2011; Church & Murray, 2009).

Spatial analysis can also be used to analyse the spatial patterns and trends for businesses, especially for fast-food chain restaurants in Malaysia. For example, one study in Indonesia discovered the spatial pattern of fast-food restaurants in Jakarta, using Average Nearest Neighbour and Kernel Density Estimation analysis for data analysis (Widaningrum et al., 2020). Spatial analysis can also identify the spatial relationship between fast-food restaurants and neighbourhood characteristics and the associations of supermarkets and fast-food outlets' availability with neighbourhood characteristics (Lamichhane et al., 2013).

Currently, in Malaysia, the use of GIS for analysing the spatial pattern of fast-food chains is still lacking. Previous studies have only focused on social aspects, such as under-age obesity, improving the image of fast food, and the behaviour of undergraduate students in consuming fast food (Krishnan et al., 2022; Mokhtar et al., 2020; Chee Cheong et al., 2019) There is a lack of analysis of the spatial patterns of the current locations of fast-food chains.

Although the spatial pattern of fast-food chains in Malaysia has been the subject of interest, no research has been conducted to date. As a result, there is a lack of understanding of the factors

influencing this pattern. This study aims to analyse the spatial pattern of three major fast-food chains in Malaysia to understand this topic better.

2.0 Methodology

To achieve the aims of this study, three phases were involved: (1) Data Collection, (2) Data Processing, and (3) Data Analysis (see Figure 1). This section discusses the study area and data, the activities carried out in each phase, and the results of the data analysis.

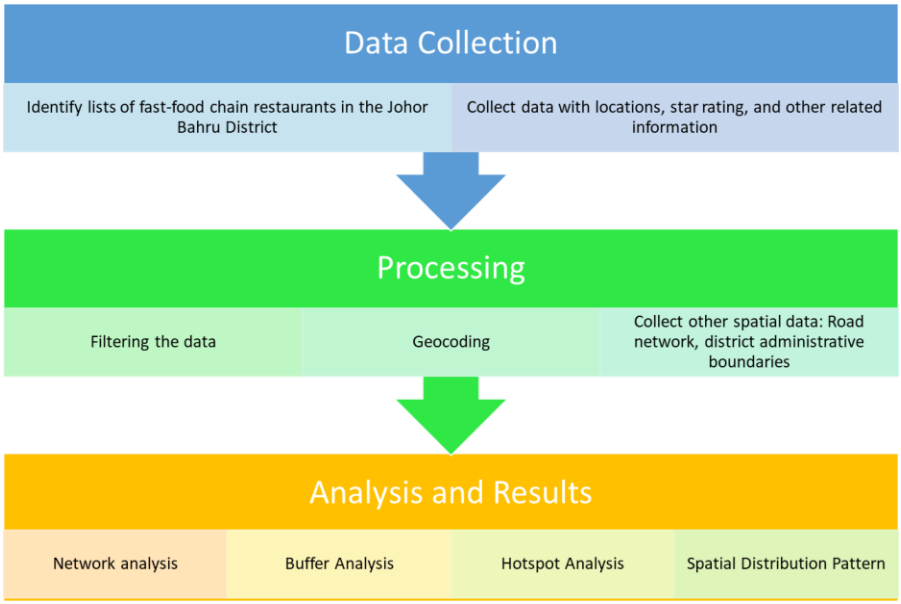


Figure 1. Steps used in this study

2.1 Study Area and Data

This study was conducted in Johor Bahru District, one of the districts in Johor State, Malaysia. Johor Bahru District is the entry point to the Malaysia-Singapore border, which has two main entry points: the Johor-Singapore Causeway and the Malaysia-Singapore Second Link. Johor Bahru was selected for this study because of its rapid development and status as an entry point to Singapore.

This study focuses on three major fast-food chain franchises: Kentucky Fried Chicken (KFC), McDonald's, and Burger King. These three major food chains were selected because of the number of restaurants they have and their popularity among residents in Malaysia. The total number of restaurants collected in this study is 81 (see Figure 2), with 40 KFC restaurants, 28 McDonald's restaurants, and 13 Burger King restaurants (see Table 1).

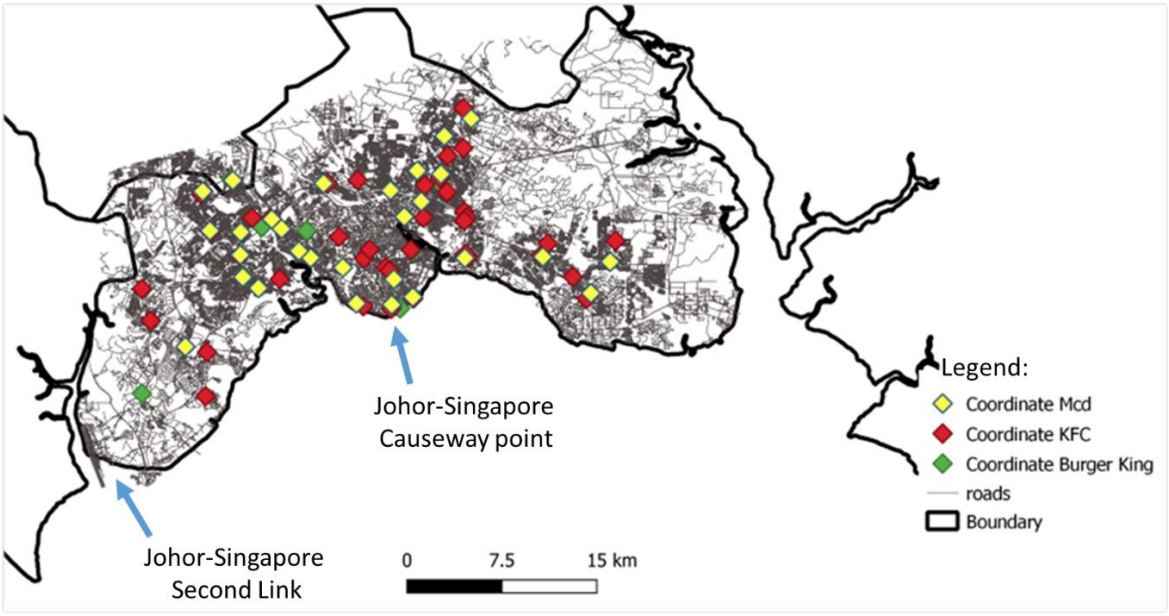


Figure 2. The study area of major fast-food chain restaurants in Johor Bahru District

Table 1. Number of 3 major fast-food chain restaurants in Johor Bahru District

Num.	Fast-food Chain	Numbers
1	Kentucky Fried Chicken (KFC)	40
2	McDonald's	28
3	Burger King	13
	Total	**81**

2.2 Phase 1: Data Collection

The data collection phase consisted of two main processes: identifying the type of fast-food chain restaurants and collecting data on the restaurants' locations. This study identified three major fast-food chain restaurants to be studied: KFC, McDonald's, and Burger King.

The data was collected from the restaurants' websites, which are updated and provide address information. Other related restaurant information was also collected, such as the locations and customer star ratings (if available). In addition, other spatial data was collected, such as road network data and the administrative boundaries of the Johor Bahru district from Majlis Bandaraya Johor Bahru.

2.3 Phase 2: Data Processing

The second phase is data processing. In this phase, the collected data was processed, filtered, and cleaned to ensure it could be used for analysis. Additionally, the data was geocoded to obtain the location of each restaurant based on the address provided on the website. This phase is critical to ensure each restaurant has a location and other attributes for the analysis phase.

2.4 Phase 3: Data Analysis

The final phase is analysis and results. In this phase, several spatial analyses were conducted, including network analysis, buffer analysis, heatmap analysis, and spatial distribution pattern analysis.

Network analysis was used to identify the coverage of each restaurant based on the road network. The analysis was conducted for three distances: 1 kilometre, 3 kilometres, and 5 kilometres. These distances were selected to see the coverage of each restaurant and the overlapping areas based on the road network analysis. The distances were also selected based on the distance and delivery time, not including the meal preparation time (Manley & Willits, 2000; Kim & Mattila, 2011; Zhang & Chen, 2010):

- One kilometre is a relatively short distance, and most people would be willing to travel this distance to reach a fast-food restaurant. The delivery time for a fast-food order would be around 5 minutes.
- Three kilometres is a slightly longer distance, and some people would be willing to travel this distance to reach a fast-food restaurant. This distance is also large enough to identify areas not well-served by fast-food restaurants. The delivery time for a fast-food order would be around 3-8 minutes.
- Five kilometres is a relatively long distance, and it is unlikely that many people would be willing to travel this distance to reach a fast-food restaurant. However, this distance can be used to identify very remote areas which may not be well-served by any restaurant. The delivery time for a fast-food order would be around 9 to 15 minutes.

The second analysis is buffer analysis, which aims to identify the restaurant's coverage based only on distance. This analysis was also done for three distances: 1 km, 3 km, and 5 km. This

analysis was selected to identify the coverage from different perspectives that are not weighted by road coverage only. Buffer analysis provides results with broader coverage than network analysis.

The third analysis is heatmap analysis, which aims to evaluate the pattern and trend of location for each fast-food chain restaurant. The results provided by this analysis can show the densest area with a higher number of restaurants within the same area.

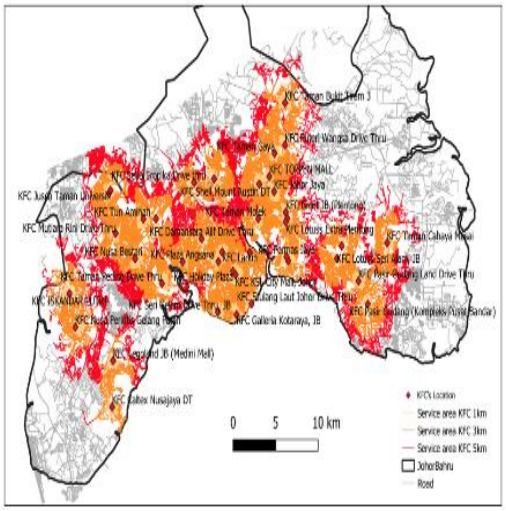
The last analysis is the spatial distribution pattern analysis, which aims to identify and analyse the distribution pattern of each fast-food chain restaurant, whether it is random, clustered, or otherwise.

3.0 Results

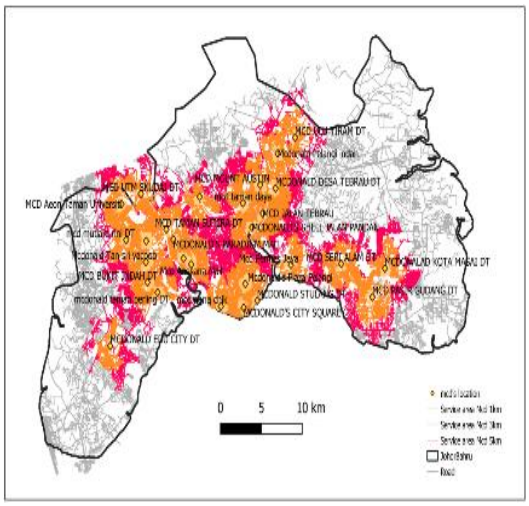
The results of this study are divided into four main parts: (1) Network analysis of food chain restaurants, (2) Buffer analysis for the food chain restaurants, (3) Hotspot analysis, and (4) Spatial distribution pattern of the food chain restaurants.

3.1 Network Analysis

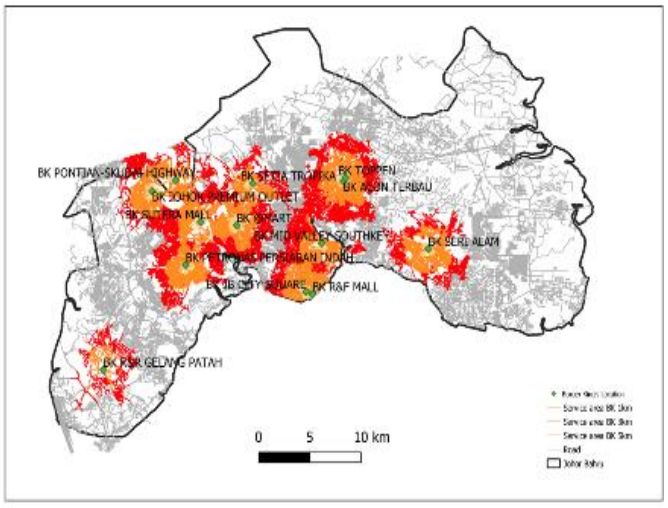
The first analysis is the network analysis. This analysis was done to identify the area that can be covered by fast food chain restaurants in Johor Bahru District at three different distances: 1 km from the restaurants, 3 km from the restaurants, and 5 km from the restaurants. These distances were selected to compare the coverage of each restaurant, which is related to delivery time (within 10 to 30 minutes). The network analysis was done for each food chain restaurant, as shown in Figure 3.



(a) KFC



(b) McDonald's



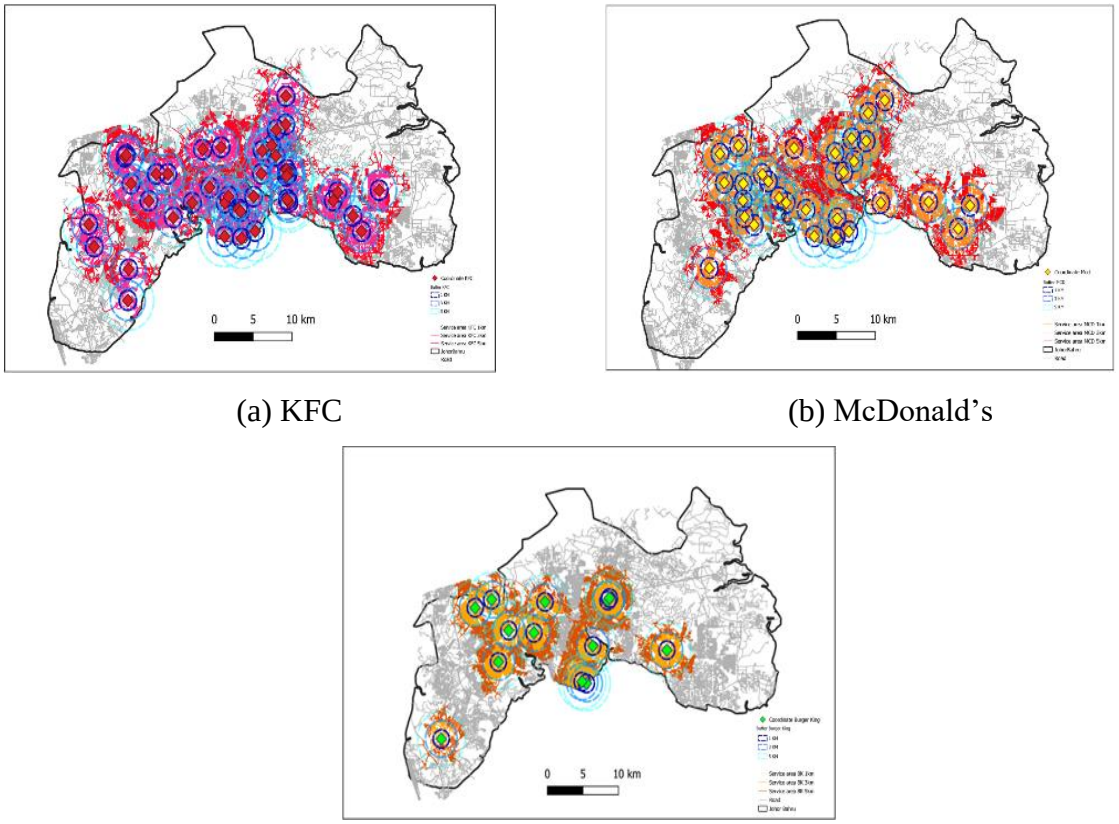
(c) Burger King

Table 3. Results of Network Analysis for all three restaurants

The results from the network analysis show that KFC restaurants cover the most area, followed by McDonald's and Burger King. The results also show that KFC and McDonald's coverage is similar, focusing on the Johor Bahru City Centre. Additionally, the results show that McDonald's and KFC have more restaurants along the Skudai-Larkin Highway, Perling-Pasir Gudang Highway, and Johor Bahru-Ulu Tiram Highway. Although Burger King does not have comprehensive coverage, it does have remote locations of its restaurants, such as in Nusajaya or the Iskandar Puteri area.

3.2 Buffer Analysis

The second analysis is the buffer analysis for each food chain restaurant. In this part, the buffer analysis was done at three main distances: 1 km, 3 km, and 5 km from the location of the restaurants. Figure 4 shows the results of the buffer analysis for KFC, McDonald's, and Burger King restaurants.



(a) KFC (b) McDonald's

(c) Burger King

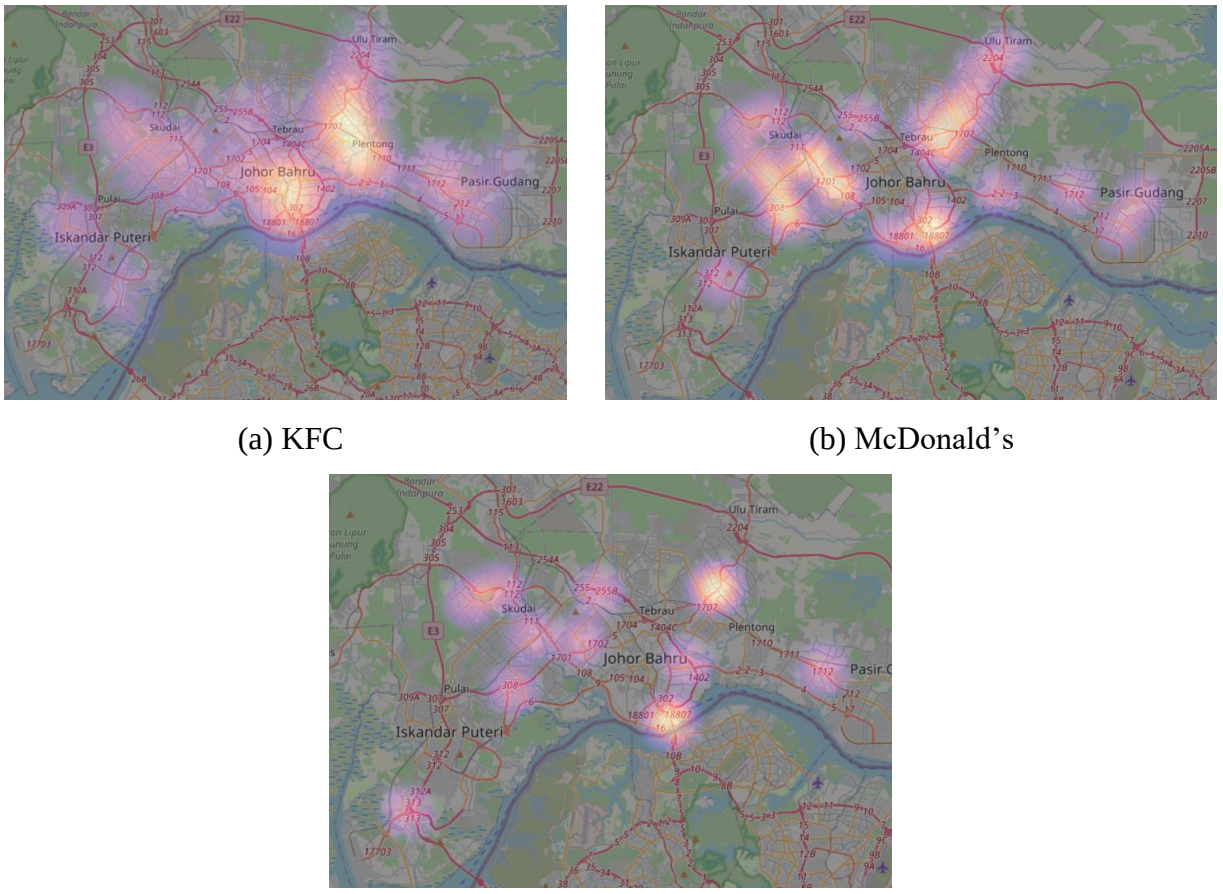
Figure 4. Buffer analysis for KFC food-chain restaurants in Johor Bahru

The results show that KFC, McDonald's, and Burger King are the most covered areas. Besides that, the coverage of KFC restaurants also indicates that it is more distributed, covering almost all locations in Johor Bahru. However, the results also show that KFC and McDonald's restaurants did not cover the area in the southwest region or the Iskandar Puteri and Nusajaya areas. Still, there is a Burger King restaurant there.

Besides that, the buffer analysis shows that most food chain restaurants focus on the Johor Bahru City Centre, with overlapping areas. This will affect the sales performance, as with shorter distances between franchisees, one franchise will have fewer customers.

3.3 Heatmap Analysis

The third analysis is the heatmap analysis. Figure 5 shows the results of the heatmap analysis of fast-food chain restaurants in Johor Bahru District.



(a) KFC (b) McDonald's

(c) Burger King

Figure 5. Heatmap for KFC, McDonald's, and Burger King restaurants

The results show that KFC restaurants are more concentrated in Johor Bahru city centre and the Plentong (east) area. McDonald's restaurants are concentrated in the centre of Johor Bahru City, Tebrau (toward Ulu Tiram), and Skudai (west) area. Burger King restaurants are concentrated in Johor Bahru City and the northeast.

These analyses show the current pattern of fast-food chain restaurant locations and can be used to extend and add new restaurants in areas that are not currently well-served. To better understand the spatial pattern of the restaurant's distribution, spatial statistical analysis can be used.

3.4 Spatial Distribution Pattern

The last analysis is the spatial distribution pattern. This analysis uses the Nearest Neighbour Analysis to indicate the distribution pattern of each fast-food chain restaurant. Table 2 shows the results of this analysis.

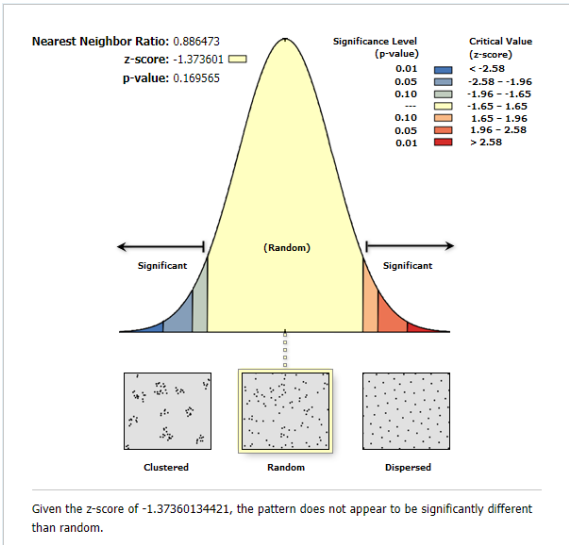
The results show that the observed mean distance for KFC is 1,762.7508 meters, McDonald's is 2,488.2333 meters, and Burger King is 3,807.5355 meters. The expected mean distance is 1,988.4996 meters for KFC, 2,133.8482 meters for McDonald's, and 2,984.3603 meters for Burger King. The nearest neighbour ratio for KFC is 0.886473, McDonald's is 1.166078, and Burger King is 1.275830.

Table 2. Results of Nearest Neighbour analysis

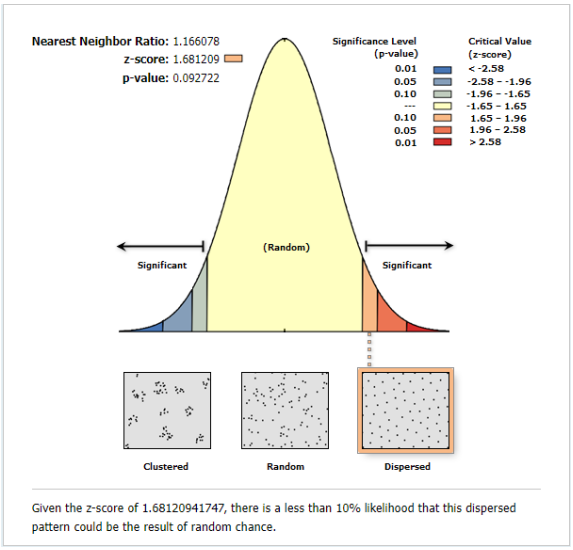
	Observed mean distance (meters)	**Expected mean distance**	**Nearest neighbour ratio**	**Num. of points**	**Z-Score**	**P-value**
KFC	1762.7508	1988.4996	0.886473	40	-1.37360	0.16956
McDonald's	2488.2333	2133.8482	1.166078	28	1.68120	0.09272
Burger King	3807.5355	2984.3603	1.275830	13	1.90258	0.05709

The z-score for KFC is -1.37369, McDonald's is 1.68120, and Burger King is 1.90258. The P-value for KFC is 0.16956, McDonald's is 0.09272, and Burger King is 0.05709. If the z-score value is less than 1, it shows the spatial distribution is random. If the z-score value is equal to 1, it shows the spatial distribution is clustered, and if the z-score value is greater than 1, it shows the spatial distribution is dispersed.

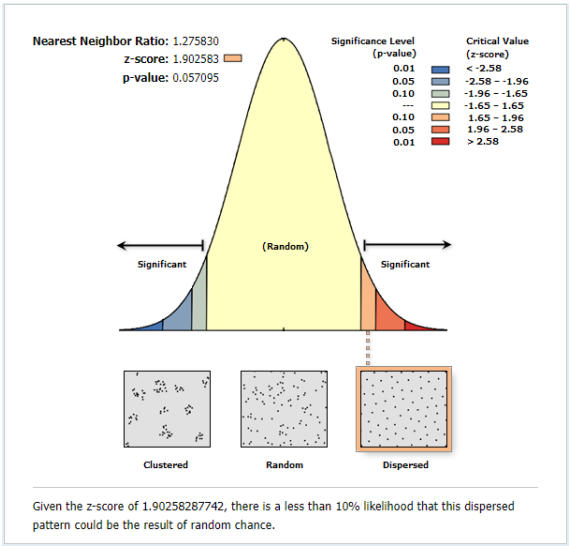
The analysis shows that the KFC restaurant distribution is random (Figure 6(a)); however, the spatial distribution of McDonald's and Burger King restaurants are dispersed (Figure 6(b) and 6(c)).



(a) Spatial distribution for KFC restaurants.



(b) Spatial distribution for McDonald's restaurants.



(c) Spatial distribution for Burger King restaurants.

Figure 6. Results for spatial distribution pattern for (a) KFC, (b) McDonald's, and (c) Burger King

4.0 Discussions

The results of this study indicate that spatial analysis and spatial statistical analysis can show the spatial distribution pattern for fast-food chain restaurants in Johor Bahru District. From the analysis, we can dictate the type of spatial pattern and use it for further expansion of these restaurants, as supported by Abubakar (2013).

From network analysis, the restaurant with the highest coverage is KFC, followed by McDonald's and Burger King. The results are also the same with the buffer analysis, where KFC has the highest coverage, McDonald's the second highest, and Burger King the lowest coverage. KFC's coverage for a 5km distance shows that KFC restaurants cover more than half of the area of Johor Bahru District, while McDonald's restaurants cover more than one-third of the area. However, Burger King only shows a quarter of the area of Johor Bahru District.

Heatmap analysis shows more spatial patterns, whereas KFC's heatmap analysis shows that the restaurant's coverage is more focused in the Johor Bahru city centre and the Plentong area. McDonald's, however, covers more in Skudai, the Johor Bahru city centre, and Tebrau towards Ulu Tiram. And Burger King's heatmap analysis shows the scattered distribution of its restaurants.

In addition, the Nearest Neighbour Analysis is also crucial for identifying the spatial pattern of these fast-food chain restaurants. Only KFC shows a random spatial pattern, while McDonald's and Burger King show results of a dispersed spatial pattern.

The results show that we can use spatial and spatial statistical analysis to analyse, compare, and identify the spatial distribution of fast-food chain restaurants' locations, especially in Johor Bahru District. We can use the results to find potential areas for each fast-food chain restaurant (Widaningrum et al., 2020). Each fast-food chain restaurant has its target, requirements, and indicators for new locations. We can identify new locations for each fast-food chain restaurant using different indicators. For example, within 1 or 2 km from the residential area, beside the main road, attached to a current or new petrol station, etc.

In addition, another future improvement is to evaluate the fast-food chain restaurants in the neighbourhood or with the demographic distribution (Lamichhane et al., 2013). Using several other data sources, such as big data or data mining from social media, we can also see the distribution and information from citizens related to fast-food chain restaurants.

5.0 Conclusion

Fast-food chain restaurants have become one of the characteristics of a city, and most cities in Malaysia have them. This study aims to analyse the spatial pattern of three fast-food chain restaurants. The results show that only KFC restaurants are randomly distributed, while McDonald's and Burger King restaurants are spatially dispersed. However, the results also show

that the concentration of each fast-food restaurant differs slightly. This study also discovered the coverage area for each fast-food restaurant, which can be used for fast-food delivery services.

Further research can be conducted to compare with more fast-food restaurants, find the best suitable locations for new locations based on their business model, and integrate with data mining or machine learning.

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