Visualization of Fast Food Restaurant Location using Geographical Information System

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Abstract. The fast food restaurant industry, as one of the food service formats, has been growing significantly in Indonesia, and still continuing in the future. Understanding of consumer behavior, as well as its various influence factors, such as demographic and socio-economic factors, are needed to be done to support decisions in a business perspective. The purpose of this research is to study the utilization of various data visualized with Geographical Information System approach, to support the decision-making process, especially related to location analysis. Fast food restaurants in Jakarta were selected as the object of this research. The results show the various information generated from the developed geographic information system and some future research were also addressed in this article.

1. Introduction
The increasingly complex business sector, with various influencing factors, and with diminishing globalization has led Indonesia to attain greater opportunities, as well as to encounter a huge number of complex challenges [1]. A further boost in productivity and competitiveness is expected through global/regional trade and investment integration [2]. The deterioration of employment opportunities expected to be handled to prevent the barrier of the economic growth [3]. To strive the vision of industrial development, Indonesia has implemented the focus of industrial development that includes: Development of Industrial Zoning, Industrial Population Growth, and Increased Competitiveness and Productivity [4].

The trade sector has supported the Indonesian economic growth in Q3/2016 [5]. And the fast food restaurant industry, as one of the food service formats, has been growing significantly in Indonesia and still continuing in the future [4, 6]. It is believed to be related to changes in people’s lifestyles [6-8]. Understanding of consumer behavior, as well as its various influence factors, such as demographic and socio-economic factors, are needed to be done to support decisions in a business perspective, as well as for industrial growth in Indonesia [9-11]. For this purpose, information systems are required to provide various data and information. For an example, by developing a geographical information system.

The discussion in this paper focuses on issues that related to the utilization of geographical information systems, in compiling and visualizing various data formats. The discussion will also be aimed at fast food restaurants as part of the food and beverage sector. Some future research directions
will be a remark in this article, related to visualization spatial data and spatial data analysis to support the development of restaurant or other business.

1.1. Geographical information system
The increasingly complex business sector, with various influencing factors, and with diminishing space and time constraints, still leaves a question, as written by Abramovich [12], “Where should a business be located and why?”. More specifically in the retail field, Grewal and Levy [13] on their review about “Retailing research: Past, present, and future”, emphasizing location as one of the most important retail success factors to continue to be studied. Research question about optimal location determination is one of the questions that often answered with Geographical Information System approach or better known as GIS [14]. Birkin, et al. [15] explained that the availability of the spatial interaction model continues to increase, but the GIS approach is still the prime methodology for finding solutions regarding location determination, especially with buffer and overlay techniques.

The pattern of socio-spatial, including demographics and lifestyles change, is important to consider in location analysis [16-18]. Such as research conducted by Austin, et al. [19] which examined the proximity of school locations to fast-food restaurants, to see food-environments that can affect children; Niti [20] that has examined the relationship between fast food restaurant performance with socioeconomic and demographic factors related to spatial data from each restaurant; and Ohri and Singh [21] proposed methodology for selection of municipal waste disposal sites.

1.2. GIS approach for spatial data visualization
Geovisualization is an approach for the development of location decision support. It aims to collect and explore spatial-temporal data and to visually reveal the peculiarities of the condition and catch the trend that happened [22]. Visualization using GIS also a popular issue in the future, with the qualitative location as the data [23].

The utilization of GIS and 3D visualization is currently growing for further and various purposes. For instance to visualize the distribution of restaurant locations compared to social-demographic of a region [24, 25]; to visualize an archeological sites [26, 27]; to support healthcare facility location decision [28]; for asset management [29]; to visualize flood-prone tourist destinations area [30]; and to assess the GIS visualization for conservation decision [31].

Visualizing the location of the restaurant is also considered important to conduct. Such as research by Prayag, et al. [32] that has mapped the location of the restaurant within a 12 year period (1996-2008) to visualize changes in land use patterns. This pattern can be studied based on the analysis result classic retail theories, i.e. central place theory, spatial interaction theory, and the principle of minimum differentiation. These theories have been proven by Reigadinha, et al. [33], appropriate for the case of the distribution of fast food restaurants.

2. Methods
GIS approach was used to visualize various spatial data from various sources. The process of data compilation and visualization using ArcGIS® Desktop 10.0 for Windows®. Various features for spatial and attribute data were used for the selection process, grouping, merging, and proximity study. The features used were clip technique, dissolve, merge, buffer, Thiessen polygon, and others. Data frame arrangement that represents various themes and processing results were conducted, as well as the determination of symbols to describe the data characteristics.

Jakarta as a megacity, which include in the 30 largest cities in the world [34], selected for the research area scope. Fast food restaurants were selected as the object of this research. A fast-food international restaurant brand was chosen to produce a more specific visualization. The selected fast food restaurant is the number 1 brand for fast-food restaurant chain based on retail sales [6] with the largest number of outlets [35].

The borderline layer of Jakarta was obtained from BPS-Statistics Indonesia. The point-of-interest locations were collected from OpenStreetMap Indonesia, as a free editable map
(https://openstreetmap.id/en/data-openstreetmap-indonesia/). These data were merged with land use map obtained from Geospasial untuk Negeri, Indonesia's geospatial portal managed by BIG – Badan Informasi Geospasial (http://tanahair.indonesia.go.id/portal/landingpage). The geocoding process has conducted to plot the distribution of fast food restaurant locations, based on their street address which can be found on each brand website.

3. Results and Discussion
Jakarta Province is divided into 6 cities, namely Central Jakarta, North Jakarta, South Jakarta, East Jakarta, West Jakarta, and Kepulauan Seribu, as can be seen in Figure 1. Of the six cities, only five cities have been invested by international brands of fast food restaurants. Therefore, the Thousand Islands city are not visualized and discussed in this article.

![Figure 1. Distribution of the studied fast food restaurant](image-url)

The number of fast food restaurants that became the main object in the study were 79 outlets, spread in 5 cities in Jakarta. The locations of this brand outside Jakarta (such as Tangerang, Depok, and Bekasi) were not discussed in this study. The location of most outlets in South Jakarta (23 outlets) and Central Jakarta (19 outlets). The geographic center of Jakarta was identified using mean center – spatial statistics tool. As can be seen in Figure 2., buffer polygons were created to a specified distance, 5 km, and 10 km.

There are 20 outlets (26% of total outlets) within the 5 km polygon buffer coverage, and there are 60 outlets (77% of total outlets) within the 10 km polygon buffer coverage. It indicates that the distribution of fast-food restaurants is concentrated in the geographical center of the Jakarta area, which is also the center of Jakarta's activities.

Population density in Jakarta can be seen in Figure 3. From this visualization, there was an interesting finding. The population density around the mean center tends to be lower when compared to the edge. Thus it can be concluded that the center of activity is not proportional to the population density in a region. Further exploration is needed to see what spatial information significantly affects the level of activity in a city, such as availability of points-of-interest.
Figure 2. Buffer polygons: 5 km and 10 km from the mean center

Figure 3. Population density in Jakarta
Points-of-interest in this article is grouped into 6 categories, referring to Widaningrum [10], i.e. education, entertainments, footfall, health facilities, and politics or business office. In Figure 4., it can be seen that the distribution of POI tends to be denser around the mean center. But visually, it was difficult to prove, even more, to know which category has a significant influence on the existence of outlets. For further study, spatial statistical analysis or data mining techniques is required.

**Figure 4.** The distribution of POI in Jakarta

**Figure 5.** Thiessen Polygon of the studied fast food restaurant and its competitors

Based on Thiessen polygon as can be seen in Figure 5., it can be concluded that the more to the center, then the coverage of fast food restaurants will be increasingly narrow. In addition to the spatial interaction studies between fast food restaurants studied with POI, their association with competitors is also important to understand. Competitors from the restaurant discussed in this article, are fast food restaurants at the 2nd, 3rd, 4th, 5th position of the top 10 global brand name based on retail sales [6].
Visually, there are indications that the distribution of competitor locations is also centered in central Jakarta and has a proximity location between fast food restaurants. Around the mean center, it can be seen that at the fast food restaurant coverage studied in this article there are up to 6 competitors outlets. It shows that there is the spatial interaction of fast-food restaurant locations between brands. But for a better confidence, a further spatial statistics analysis is needed.

4. Conclusions
The results show the various information generated from the developed geographical information system. Visually it can be captured that the distribution of fast food restaurant locations in a city is in line with central place theory and spatial interaction theory. The density of fast food restaurant locations more tightly in the central of Jakarta and has a proximity location with competitors.

There is an indication that Point-of-Interest in the surrounding of fast food restaurant has a causal relationship. It shows that the determination of fast food restaurant location does not occur randomly. This needs further examination to find attributes that significantly influence the determination of fast food restaurant locations.

For further research, Anselin [36] explained that with the ease of utilization of GIS, it often overrides the concepts of spatial statistics. In addition, as Chung, et al. [37] explained, analysis to be performed outside of the geographic information system and available data is aggregate data, poses many challenges in spatial statistical analysis. Application development [22] or web-based GIS [38, 39] is also an important study to cover the limitations of traditional GIS. Furthermore, Hernandez [22] explained that GIS has a limitation on visualize change for exploring the spatial-temporal dimension purposes.

Another futuristic research is the visualization of spatial information from website or social media, as discussed by Zhai, et al. [40] who visualized the popularity of restaurants based on Consumer review website (CRW); Liu, et al. [41] reveals travel patterns based on check-in data from social media; dan Comito, et al. [42] who discovered people/community movement behavior to mine frequent travel route and interesting point of interest locations.

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