Spatial Pattern Analysis of Food Service Locations in Five Major Cities in Indonesia

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ABSTRACT: Previous research has found spatial patterns in fast-food restaurants. In addition to the tendency for fast food restaurants to be close to each other, the data shows co-location rules between fast food restaurants and six facilities that support work, health, spirituality, education, travel, and leisure/shopping activities. Fast food service providers can use the research results as a reference for service development. The problem is whether all categories of food services can refer to this finding. This study aimed to analyze the spatial pattern of food services (not only fast food) in five major cities in Indonesia. This study uses point-of-interest location data from OpenStreetMap, where there are eight categories of food services, including bakery, bar, beverages, cafe, convenience, fast food, food court, and restaurant. Five major cities in Indonesia, namely Jakarta, Bandung, Surabaya, Semarang, and Medan, were selected to analyze proximity patterns between each food service category and various facilities identified in previous studies. QGIS and PostgreSQL software are the primary tools for managing and analyzing spatial data. The computational results of proximity analysis will show whether there are significant differences in patterns for each category of food services in each city. The information generated from this research contributes to food service providers more broadly, as well as other businesses with a particular pattern of closeness with each category of food services. The identified inter-service network is also an input for spatial and regional planners in determining a compact business area.

1. INTRODUCTION

Food is a primary human need. Nationally, Indonesia's average monthly per capita food expenditure is around USD 80.29. Nineteen provinces in Indonesia are above the national average, with Jakarta as the highest and Nusa Tenggara as the lowest per capita expenditures. The average expenditure per capita is 50.65% for food and 49.35% for non-food [1]. Currently, many food services have spread across Indonesia, and restaurants are one of the services most frequently visited by Indonesian consumers in the 2017-2018 period, especially middle-class consumers who earn the highest average gross income [2]. Restaurant and hotel consumption grew the fastest at 5.7% in private consumption when private consumption accounted for more than half of GDP in the 2nd quarter of 2018 [3]. Technological developments affect GDP growth aided by growth in per capita income and lifestyle changes [4]. Consistent with the trend of comfortable lifestyles and the need for food and drink (with time constraints), prompting food service providers to find the right location to develop food services. Food services are part of the food industry and drinks, including bakeries, bars, beverages, cafes, convenience, fast food, food court, and restaurant. They need a specific location and space to serve consumers, regardless of whether consumers will dine in or take food to another location [5]. Availability and access to locations, along with menus, ambiance, prices, variety, and cleanliness, are the basic needs of consumers in various segments [6].

In previous studies, to our knowledge, no research has specifically discussed the spatial characteristics of food service from food service locations considered as previous locations or locations where consumers consume products from food services. This study aimed to determine the pattern of spatial food services in five major cities in Indonesia, including Jakarta, Semarang, Yogyakarta, Surabaya, and Bandung, to determine the pattern of proximity between each food service and various other public facilities. The location of this food service is also influenced by other facilities such as hotels, residential housing, tourist sites, schools, supermarkets, and workplaces. The location of food services and other facilities as driving factors will be analyzed simultaneously using a co-location mining approach. This study can provide more in-depth information about the spatial characteristics of food services, including bakeries, bars, beverages, cafes, convenience, fast food, food courts, and restaurants. This information can be used as consideration in deciding to determine the food service's location. Information related to spatial data (publicly available) in this study was taken using open-source and adequate software. Thus, the information in the analysis contained in the research can be used for business or academic purposes.

2. LITERATURE REVIEW

2.1 Bibliometric

Mapping and clustering are complementary or mutually exclusive. The occurrence terms map was generated to obtain a detailed picture of the structure of a bibliometric network [7]. Figure 1 shows a visualization the existence of a circle which indicates that the larger the circle, the greater the number of words that appear in the abstract and the title of the article that is relevant to the keyword or term [8]. In the visualization, it can be exemplified as the relationship between service and city in the blue circle on the left, closer than the relationship between service and number. From the analysis results, it is known that with the term food services obtained from metadata, as many as 1,752 articles can be grouped into three clusters, each of which can be identified based on its color.

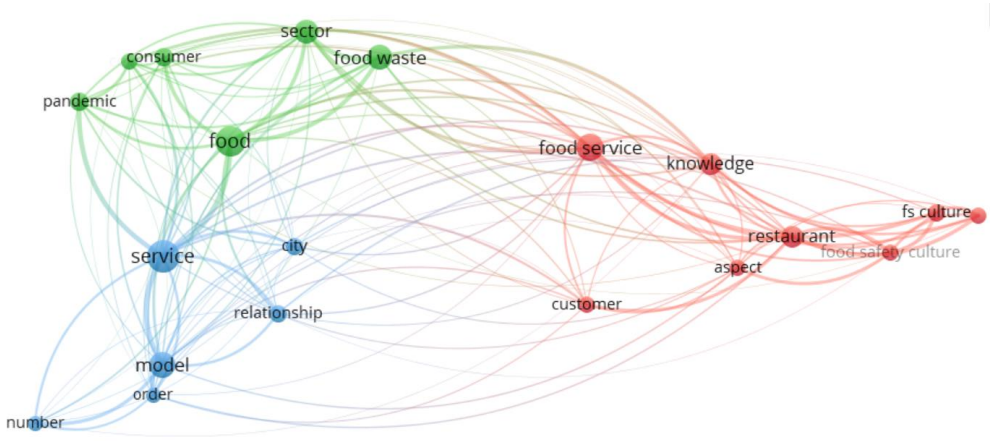


Figure 1 Bibliometric

The total link strength is generated using a minimum number of occurrences of 10 conditions, then 138 relevant results were found. The first cluster is the red on the right, which has eight items covering aspects, customer, food handler, food safety culture, food service, fs culture, knowledge, and restaurant. The second green cluster in the upper left corner has six items dominated by terms such as food, sector, consumer, pandemic, covid, and food waste. The third is the blue cluster on the left which has six items with terms such as city, model, number, service, relationship, and order. This study will focus on the terms service and city because this study aims to determine the pattern of spatial food services in five major cities in Indonesia.

2.2 Spatial Concept

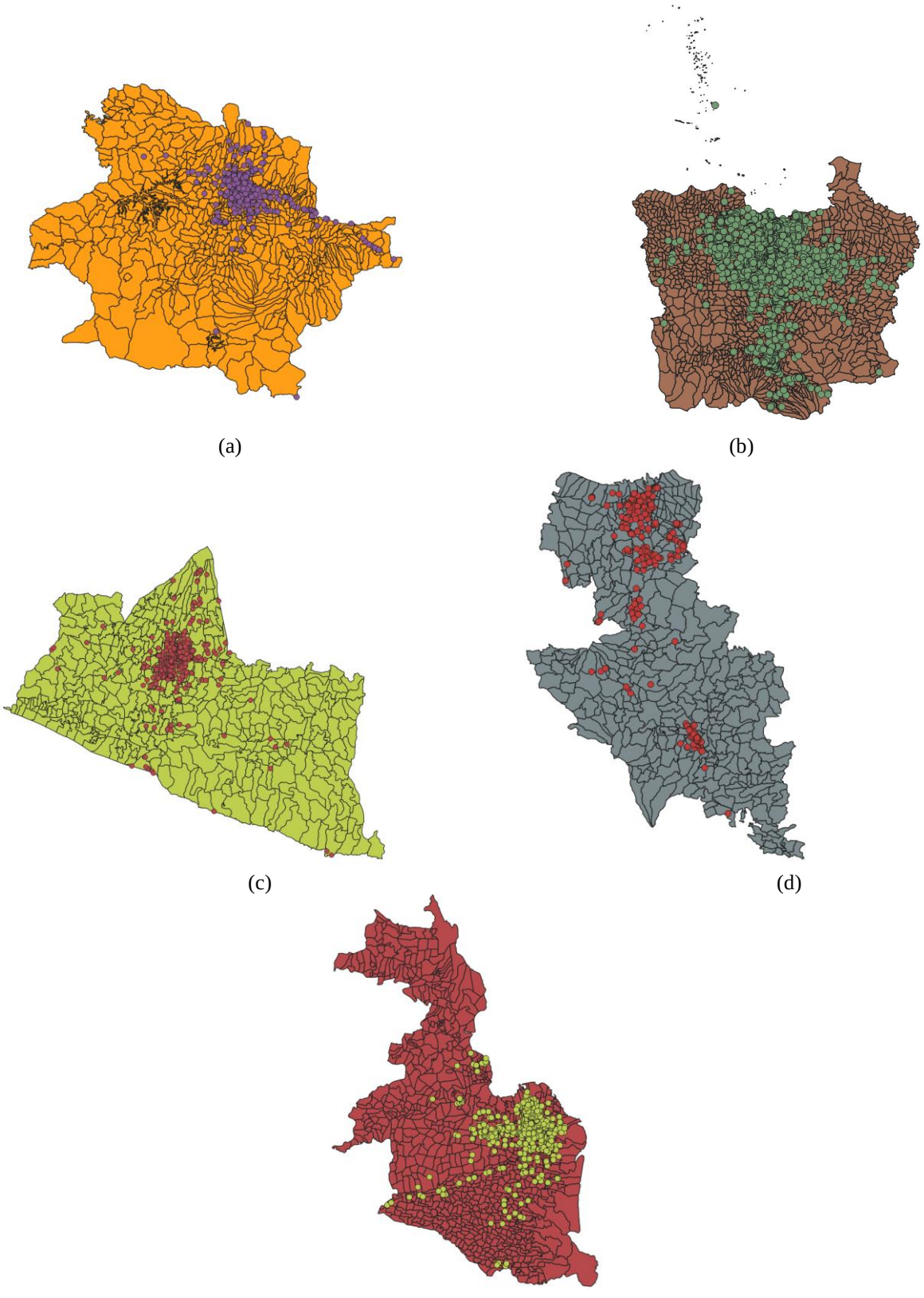
Geographic Information System (GIS) technology is a technology that can collect, manage, manipulate, and geographically visualize spatial data (spatial) related to the position of the earth's surface on a map according to the actual position of the earth's surface with coordinate point information and can produce geographic information in the form of a digital map. From the opinion of experts, it can be concluded that mapping with digitization is critical because it can be used to view or translate data into the form of mapping visualization [9]. The benefit of GIS is that it makes it easier for users in decision-making to determine what will be taken, especially regarding spatial aspects. With this technology, it will be easier in terms of location mapping, one of which is mapping to determine the location of food services. One of the data models used in Geographic Information Systems (GIS) is spatial data that stores surface features earth, such as roads, rivers, and others. Data spatial models are divided into the data model vector and the data model raster [10]. GIS and spatial analysis are related to the quantitative location of essential features, as well as the properties and attributes of these features [11]. QGIS is one of the study areas in this research and is a user-friendly Open Source of GIS processing software. In the expert's opinion, it can be said that QGIS can be used well in online digitization processing because of its open-source nature [9].

3. METHOD AND DATA

3.1 Method

The research was conducted by finding the coordinates of food services in five major cities in Indonesia, including Bandung, Jakarta, Yogyakarta, Semarang, and Surabaya. The data results are then mapped into QGIS with the WGS84 estimation system at the appropriate locations for the five cities. Road and rail data also need to be exported to QGIS, which will then be one of the research analysis materials. In addition to using QGIS to assist in grouping existing

data, QGIS also uses PostGIS, allowing developers to add support for geographic objects that execute location queries run in PostgreSQL. The analysis is carried out by looking at the results of the overlay of the relationship between railways, roads, and food services.



(a) (b) (c) (d) (e)

Figure 2 a) Food Services Location in Bandung b) Food Services Location in Jakarta c) Food Services Location in d) Food Services Location in Semarang e) Food Services Location in Surabaya

3.2 Data

The data used in this study are regional boundaries, food service locations, and points of location interest (POI). The administrative boundary data of this study were obtained from Badan Pusat Statistik, together with regional population data. Meanwhile, food service locations and points of location interest (POI) (object of this research) are geocoded based on their addresses, which were obtained from OpenStreetMap Indonesia (https://download.geofabrik.de/asia/indonesia.html).

4. RESULT AND DISCUSSION

The analysis uses the nearest neighbor in QGIS, which can be seen in Table 1. The nearest neighbor index defines the difference between the observed average distance (based on food location data) and the expected average distance (based on the hypothesis that the data is randomly distributed). An index value below 1 indicates a clustering tendency. Therefore, in general, food service is impatient or generally looks for it. Several food-service types are more spread out or not grouped, namely the food court. A food court is a place for food service that is quite complete because, in general, there are many types of food or drinks in it so that the food court does not spread.

Table 1 Statistic Result of Nearest Neighbor

Region	Food Services								
Bandung	**Bakery**	**Bar**	**Beverages**	**Cafe**	**Convenience**	**Fast Food**	**Food Court**	**Restaurant**	**All**
Observed mean distance	868.20	1148.59	5306.6	480.43	805.24	901.61	1650.61	234.19	203.94
Expected mean distance	995.05	1070.07	3394.10	931.62	2096.79	1406.73	1300.04	1027.44	943.13
Nearest neighbor index	0.87	1.07	1.56	0.51	0.38	0.64	1.26	0.22	0.21
Number of points	34	15	6	140	136	75	16	522	944
Z-score	-1.42	0.54	2.64	-10.96	-13.74	-5.94	1.06	-33.74	-46.06
Jakarta	**Bakery**	**Bar**	**Beverages**	**Cafe**	**Convenience**	**Fast Food**	**Food Court**	**Restaurant**	**All**
Observed mean distance	995.29	1305.28	3302.48	193.11	362.28	646.20	2316.52	326.98	193.11
Expected mean distance	1959.16	2329.26	4336.04	812.13	1255.74	1779.38	4653.03	1281.68	812.13
Nearest neighbor index	0.50	0.56	0.76	0.23	0.28	0.36	0.49	0.25	0.23
Number of points	290	112	20	3952	1057	440	58	1365	3952
Z-score	-16.02	-8.90	-2.03	-91.66	-44.25	-25.55	-7.31	-52.64	-91.66
Yogayakarta	**Bakery**	**Bar**	**Beverages**	**Cafe**	**Convenience**	**Fast Food**	**Food Court**	**Restaurant**	**All**
Observed mean distance	2232.10	592.01	2450.16	648.73	702.61	1447.88	2120.74	348.42	252.83
Expected mean distance	2218.03	821.36	1492.38	2044.93	1140.48	2575.61	2081.52	1510.75	1164.03
Nearest neighbor index	1	0.72	1.64	0.31	0.61	0.56	1.01	0.23	0.21
Number of points	15	19	7	129	91	57	16	488	822
Z-score	0.047	-2.32	3.24	-14.83	-7	-6.32	0.14	-32.51	-42.93
Semarang	**Bakery**	**Bar**	**Beverages**	**Cafe**	**Convenience**	**Fast Food**	**Food Court**	**Restaurant**	**All**
Observed mean distance	3837.95	0	17493.72	1417.33	453.13	1258.03	845.99	458.49	282.27
Expected mean distance	3729.75	0	7612.26	2712.96	1459.24	2149.80	3070.82	1293.25	1023.09
Nearest neighbor index	1.02	NAN	2.29	0.52	0.31	0.58	0.27	0.35	0.27
Number of points	8	1	3	39	106	36	15	127	335
Z-score	0.15	NAN	4.30	-5.70	-13.57	-4.76	-5.36	-13.91	-25.35
Surabaya	**Bakery**	**Bar**	**Beverages**	**Cafe**	**Convenience**	**Fast Food**	**Food Court**	**Restaurant**	**All**
Observed mean distance	903.26	0	0	372.78	726.91	898.42	3374.78	296.51	202.19
Expected mean distance	1386.15	2657.60	0	911.45	1441.75	1824.68	2577.45	735.12	679.07
Nearest neighbor index	0.65	0	NAN	0.40	0.50	0.49	1.30	0.40	0.29
Number of points	37	10	1	267	153	58	11	343	880
Z-score	-4.05	-6.04	NAN	-18.47	-11.73	-7.39	1.96	-21.13	-39.85

Food services in this study include bakery, bar, beverage, café, convenience, fast food, food court, and restaurant. The analysis carried out is to see what facilities are located around the food service for a distance of less than 1 km in 5 major cities in Indonesia (Bandung, Jakarta, Yogyakarta, Semarang, and Surabaya), the data processing is done by using the pivot on Microsoft Excel, which is shown in Figure 3.

Food Service Type of Facilities in 5 City

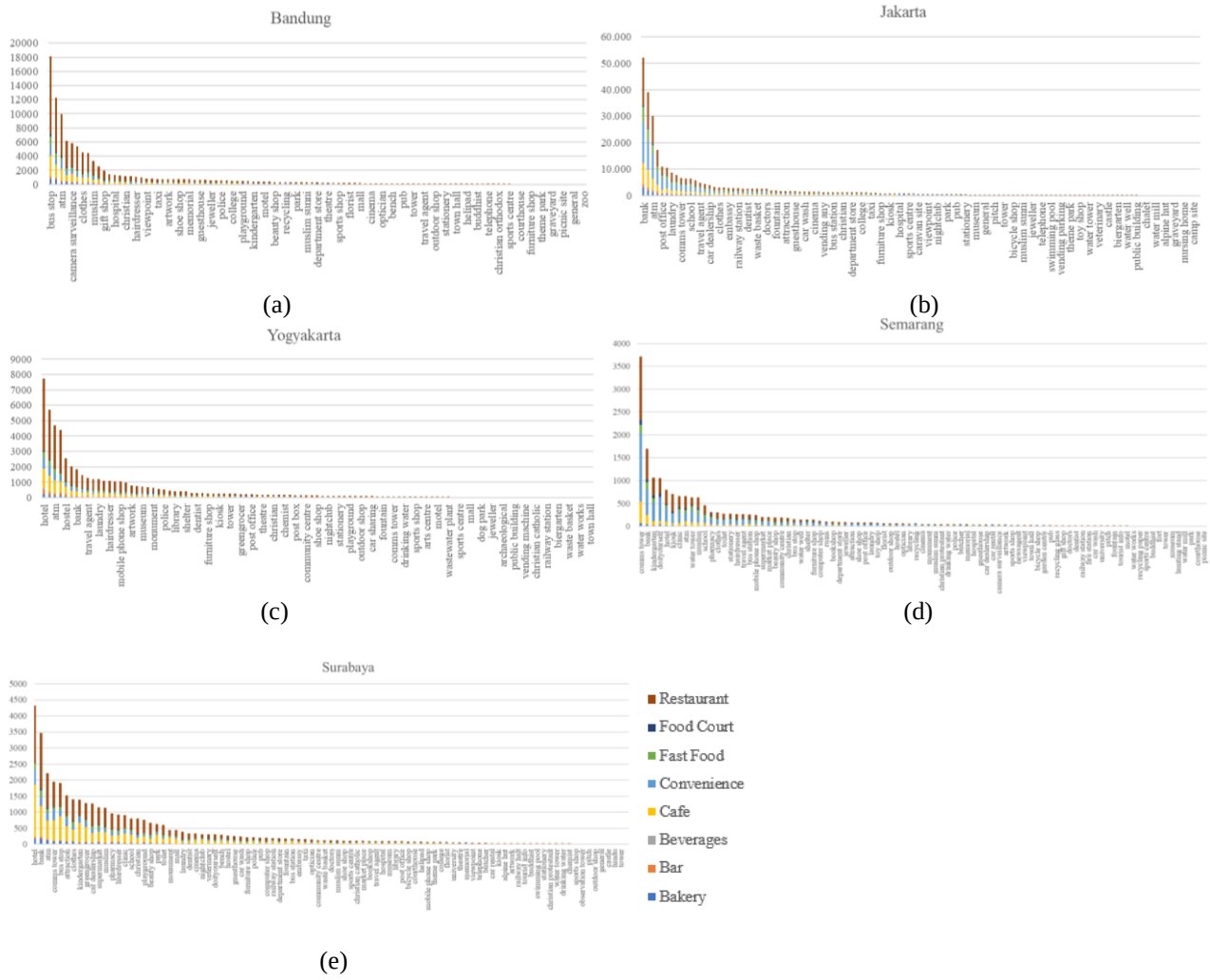


Figure 3 a) Food Service Type of Facilities in Bandung b) Food Service Type of Facilities in Jakarta c) Food Service Type of Facilities in Yogyakarta d) Food Service Type of Facilities in Semarang e) Food Service Type of Facilities in Surabaya

The results showed that overall food service support facilities in 5 major cities in Indonesia with a distance of less than 1 km were banks, bus stops, ATMs, hotels, and schools. In general, people in big cities are active around these supporting facilities, so there are a lot of food services there. Facilities such as banks and ATMs are generally located close to office areas, so they are usually in the middle of a busy city, bus stops are places for people to move, so many people come to go to work, school or even out of town. According to BPS, the total population of Bandung, Jakarta, Yogyakarta, Semarang, and Surabaya in 2020 is 2.444.160, 10.562.088, 373.589, 1.687.208, and 2.874.314. From Figure 3 the most food service-supporting facilities in Jakarta are banks, bus stops and ATMs. This can be caused by many residents in Jakarta, so that the hotel is not the most influential supporting facility compared to the three facilities. Meanwhile, hotels are the most common food service supporting facilities in the cities of Yogyakarta, Bandung, and Surabaya because these three cities are three cities that tourists in Indonesia quite frequently visit, so there are many food services around the hotel. Schools are also one of the supporting facilities for food service because students will need food service, for example, at lunchtime or just buying drinks. Figure 3 shows that overall, 5 big cities in Indonesia have the same food service support facilities, which are dominated by bus stops, banks, ATMs, hotels, and schools.

Table 2 Points-of-Interest for Each Minor Attribute

Main Activity	Minor Attributes	POIs based on OpenStreetMap				
		Bandung	Jakarta	Yogyakarta	Semarang	Surabaya
Leisure time/ shopping	Shopping Stores	Bookstore (159), Gift Shop (1994), Car Dealership (542), Department Store (284) , Furniture Shop (10), Mall (216), Greengrocer (23) , Computer Shop (148), Bicycle Shop (150), Sports Shop (240), Outdoor Shop (135), Toy Shop (369), Shoe Shop (740), Beauty Shop (355), Mobile Phone Shop (753)	Bookstore (1258), Gift Shop (841), Car Dealership (3879), Department Store (1271), Furniture Shop (884), Mall (1799), Greengrocer (852), Computer Shop (321), Bicycle Shop (270), Sports Shop (436), Outdoor Shop (578), Toy Shop (109), Shoe Shop (942), Beauty Shop (429), Mobile Phone Shop (1280)	Bookstore (460), Gift Shop (245), Car Dealership (72), Department Store (23), Furniture Shop (273), Mall (25), Greengrocer (229), Computer Shop (169), Bicycle Shop (36), Sports Shop (64), Outdoor Shop (97), Toy Shop(97), Shoe Shop (132), Beauty Shop (420), Video Shop (85), Mobile Phone Shop (1047)	Bookstore (106), Gift Shop (22), Car Dealership (37), Department Store (96), Furniture Shop (144), Computer Shop (117), Bicycle Shop (25), Sports Shop (33), Outdoor Shop (65), Toy Shop (71), Shoe Shop (86), Beauty Shop (197), Mobile Phone Shop (245)	Bookstore (100), Car Dealership (1269), Department Store (189), Furniture Shop (216), Mall (436), Greengrocer (1287), Computer Shop (196), Bicycle Shop (88), Sports Shop (10), Outdoor Shop (70), Shoe Shop (114), Beauty Shop (662), Mobile Phone Shop (73)
	Marketplace	Market Place (517), Supermarket (5430)	Market Place (1486), Supermarket (5769)	Supermarket (1069)	Market Place (200), Supermarket (207)	Market Place (109), Supermarket (1153)
Traveling	Hotel	Guesthouse (660), Hostel (406), Hotel (12277), Motel (372)	Guesthouse (1682), Hostel (1333), Hotel (17256), Motel (186)	Guesthouse (4390), Hostel (2538), Hotel (7721), Motel (55)	Guesthouse (4390), Hostel (2538), Hotel (7721), Motel (55)	Guesthouse (250), Hostel (78), Hotel (292)
	Terminals	Bus Station (968), Bus Stop (18161) Railway Station (235)	Bus Station (1318), Bus Stop (38793), Railway Station (2736)	Bus Station (1210), Bus Stop (5701), Railway Station (7), Ferry Terminal (1)	Bus Station (256), Bus Stop (154), Railway Station (18)	Bus Station (175), Bus Stop (1914), Railway Station (190)
Education	Schools	Kindergarten (259), School (4481), University (816) , Collage (527)	Kindergarten (6526), School (6416), University (622), Collage (1218)	Kindergarten (260), School (1466), University (257), Collage (118)	Kindergarten(1068), School (464), University (17)	Kindergarten (1392), School (804), University (58), Collage (68)
Religious Activity	Worship Facilities	Christian (1183), Christian Protestant (105), Buddhist (78), Muslim (2207), Muslim Sunni (293), Christian Orthodox (46)	Christian (1306), Christian Catholic (1), Christian Protestant (86), Buddhist (160), Muslim (2615), Muslim Sunni (251), Hindu (3)	Christian (189), Christian Catholic (7), Muslim (2040), Muslim Sunni (2745), Muslim Shia (7), Hindu (21)	Christian (189), Christian Protestant (48), Buddhist (4), Muslim (630), Muslim Sunni (49)	Christian (802), Christian Catholic (110), Christian Protestant (14), Buddhist (18), Muslim (1131), Muslim Sunni (116), Hindu (2)
Health Activity	Hospitals	Hospital (154), Pharmacy (1401), Dentist (218), Doctors (101), Clinic (442)	Hospital (1352), Pharmacy (1401), Dentist (218), Doctors (171), Clinic (770)	Hospital (124), Pharmacy (997), Dentist (292), Doctors (117)	Hospital (40), Pharmacy (314), Dentist (20) Doctors (21), Clinic (662)	Hospital (94), Pharmacy (958), Dentist (339), Doctors (125), Clinic (908)
Work Activity	Government Offices	Police (685), Post Office (603)	Fire Station (100), Police (2659), Post Office (10911)	Police (208), Post Office (522)	Fire Station (18), Police (47), Post Office (86)	Police (214), Post Office (89)

Based on previous research, there are co-location rules between fast-food restaurants and six facilities that support activities. This study also conducted research based on work activities listed in Table 2. There are six main activities related to consumer behavior in buying products from food services: leisure/shopping time, traveling, education, religious activities, health activities, and work activities. From these various activities, there are many opportunities for consumers to come to food services when carrying out one of the activities leading to these activities because, with a distance of 1 km, consumers can walk to the food services area either to buy lunch at fast food, restaurants, and food courts. Even just buying drinks or snacks at bakery, beverage, café, and convenience.

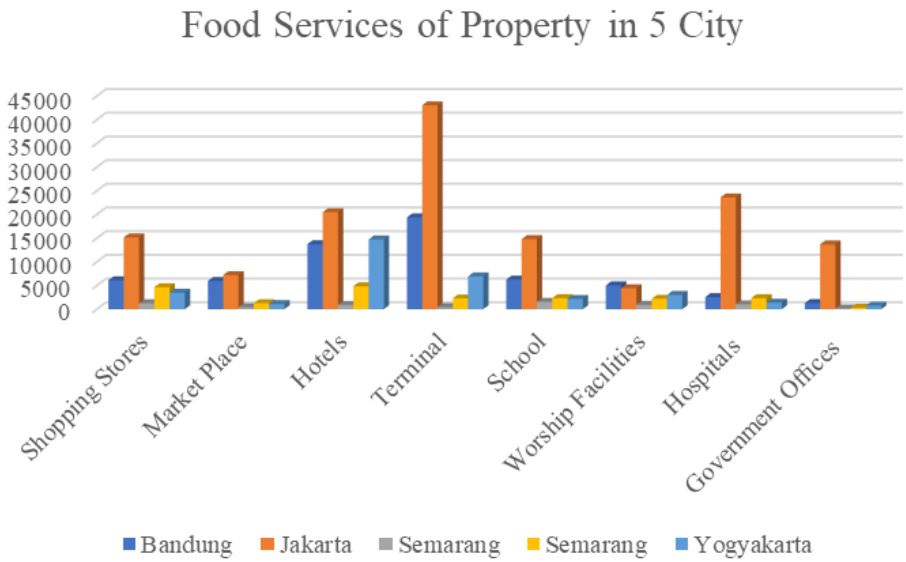


Figure 4 Food Services of Property in 5 City in Indonesia

From the main activities carried out by consumers, there are 8 properties that can support these 6 main activities. In figure 4 there is a graph that shows the number of 8 properties in 5 big cities in Indonesia that are around food services.

The results show that the most significant number of properties around food services are in the city of Jakarta, this can be since the population of Jakarta is the largest, and especially Jakarta is the capital city of Indonesia, so there are many public facilities. The smallest number of supporting facilities is in Yogyakarta because of the small population. The most significant number of supporting facilities are hotels and terminals. A large number of hotels and terminals in food services supporting facilities shows that areas located in supporting facilities are very suitable to be used as locations for food services.

Table 3 The Number of POIs for Types of Food Services

Minor Attribute	Bakery	Bar	Beverages	Cafe	Convenience	Fast Food	Food Court	Restaurant
Shopping Stores	1376	681	190	5337	5474	2917	593	14064
Market Place	732	332	72	2639	2189	1399	277	8242
Hotels	2154	1945	314	9612	8270	4479	546	27309
Terminal	3173	1832	203	12805	14390	7032	946	31636
School	1527	444	156	4460	6266	2483	421	11325
Worship Facilities	662	314	94	2476	2406	1279	322	8004
Hospitals	1640	629	185	4788	8918	3190	397	11141
Government Offices	762	399	54	2120	5497	1683	177	5450

Table 3 shows that each type of food service has a different number of supporting facilities. The main supporting facilities around the bakery, convenience, and fast food are terminals, hotels, and hospitals; around bars, drinks, cafes, food courts, and restaurants are hotel terminals and shopping stores. In general, the supporting facilities for each type of food service are the same as terminals, hotels, hospitals, and shopping stores. Food services can also affect the surrounding supporting facilities, for example, a food court where there are generally shopping shops because consumers generally will find food after shopping, or a food court is a service that provides various types of food and drinks to tenants.

5. CONCLUSION

This study describes the availability of supporting facilities around food service at a distance of less than 1 km in 5 cities in Indonesia, including Bandung, Jakarta, Yogyakarta, Semarang, and Surabaya. After analyzing the spatial characteristics of 8 types of food service from five cities, there is a tendency for grouping at the location of bars, bakeries, beverages, cafes, convenience, fast food, and restaurants, while the tendency is to spread out in food court locations. In addition, an indication of the similarity of food service support facilities was also found in 5 cities. Hotels are the main supporting facilities for overall food service in every city, especially in Yogyakarta, a city tourists visit. There is an indication of the similarity of supporting facilities for food service, so further statistical tests are needed to prove this. This study also groups supporting facilities based on six main activities, including leisure time/shopping activities, travel, education, religious activities, health activities, and work activities (government offices) so that the results obtained that the main supporting facilities for food service in general are hotels and terminals.
Meanwhile, if grouped by type of food service, each food service has different supporting facilities. Around bakeries, bars, beverages, cafes, fast food, and restaurants are generally dominated by hotels and terminals; around convenience, there are generally terminals and hospitals, while for food courts, there are generally shopping stores and terminals. Food services can use the results of this study as a reference to determine the optimal location by looking at the urban services that are most frequently visited and desired by consumers, thereby increasing the livability and efficiency of future cities.

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