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Modeling waste generation in the Gayamsari Sub-district service trade area with a spatial approach

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ABSTRAK

Based on the Semarang City Regulation No.5 of 2004 concerning the Semarang City Spatial Plan 2000-2010 Article 11, Gayamsari Sub-district is included in BWK V, which is an area with the center of trade, office, and residential activities that contribute significantly to the increase in waste generation in Semarang City every year. The existence of this waste problem requires an identification study related to waste generation, consisting of characteristics, volume, and composition of waste visualized through spatial modeling. In this study, waste generation was measured in 30 sample shops in the trade and service area of Gayamsari Subdistrict. Then, the analysis used was Descriptive Statistical analysis, GIS analysis, and Moran's I analysis. The research results generated from the implementation of this research are waste generation data in the form of total weight of waste generation, weight per type of waste, average weight of waste, and kind of waste composition through spatial analysis resulting in mapping the location of sample stores, the level of waste, and the range of neighborhoods around the store, and through Moran's I analysis resulting in the identification of spatial autocorrelation between sample stores, the form of spatial patterns, and hotspot maps of waste generation distribution. The research results are used to conclude the application of the non-residential urban area waste measurement method in SNI 19-3964-1994.

Keywords: Spatial modeling, trade and service area, waste generation

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INTRODUCTION

According to the Ministry of Environment and Forestry (KLHK), in 2021, Indonesia has a total waste of 21.88 tons. The garbage decreased by 33.33% compared to 2020, which reached 32.82 tons of trash, while in 2019, Indonesia's waste generation reached 29.14 tons. Based on this data, it can be seen that the trendline of the amount of waste Generation from year to year fluctuates, not continuously increasing or decreasing.

The waste problem is a problem that every city must face because as the city grows, land use becomes more complex, and the waste generated will increase in volume and variety (Minghua et al., 2009). Varieties of waste originating from household, agricultural, construction, medical, industrial, and other wastes will cause problems if not appropriately managed (Dehghani et al., 2021).

Industrial waste, as well as waste from trade and service areas, has a significant impact on the environment because it produces a wide range of waste, varies in quantity and type, and contains hazardous chemicals (Begum et al., 2007). These waste-related problems are also exacerbated by the lack of land and waste disposal facilities and community participation in waste management (Yukalang et al., 2017).

Looking at Indonesia's waste generation in 2021, Central Java Province is the most significant contributor, with a total of 3.65 tons of waste generated. Semarang City, which is one of the major cities in Indonesia and the capital of Central Java Province, is certainly not free from waste problems, as the capital of Central Java Province, which is the center of activity and the higher level of in and out migration makes Semarang City vulnerable to waste problems which are the residue of human activity. The trade and services sector is one of the sectors that has an essential role in a city's economic development. Gayamsari Sub-district, included in BWK V, is the center of trade and services sector activity.

Problems regarding waste generation, composition, and characteristics are essential things that must be considered in preparing a waste management system in a particular area, such as trade and service areas. According to Damanhuri (2010), these three variables will be interconnected in determining the supporting elements of waste management, such as equipment selection, shelters, collection tools, transportation, transportation routes, area, and type of landfill.

The urban waste management system needs special attention from all parties because it will be a big problem if there is an imbalance between waste production and processing and the reduction of environmental quality due to using functions as a landfill (Minghua et al., 2009). Currently, waste generation modeling for trade and service areas is still not widely made, so there is still a lack of lessons learned in urban waste management in trade and service areas.

The results of research on waste management in urban areas in Sri Lanka show that urban communities need to work with the Government in personal and waste management in the form of private waste management agencies so that the waste contained in urban areas can be managed optimally. In contrast, in rural communities or rural areas, it can be easier to manage the waste they produce because the type of waste produced is dominated by biodegradable waste (easily decomposed), and the availability of a wider land area when compared to urban areas to manage waste (Saja et al., 2021). The following are some of the problems that arise from this waste: waste will disturb the comfort and beauty of the city if there is a lot of scattered or piled-up garbage. Waste piled up in large quantities can become a nest for pests such as rats, germs, and other parasitic organisms that can negatively impact environmental health and the health of organisms living around waste piles (Siddiqua et al., 2022). Waste can also contribute to air pollution through dry waste in the form of dust and odorous waste, which can disturb the respiratory tract (Kanhai et al., 2021).

Using a spatial approach by examining the correlation between variables and the shape of the spatial pattern of variables can help prioritize waste generation management in trade and service areas based on the development and dynamics of land use (El-Hallaq & Mosabeh, 2019). The benefits of spatial data will be helpful as information in waste management using a statistical spatial analysis approach can also be used to identify the form of spatial patterns (clustered or not clustered), the direction of growth, and the formation of a concentration or cluster (Madden et al., 2021).

Based on field observations and document review, it can be seen that the Gayamsari Sub-district, which is the center of activities in the trade and services sector according to the Semarang City RTRW, has a total of approximately 414 shop units spread across the northern and southern areas. The concentration of the distribution of shops in the trade and service area of Gayamsari Sub-district is in the south, namely along Jalan Majapahit, which is an arterial road classification, as well as on Jalan Gajah Raya (collector road) which is located in the central part of Gayamsari Sub-district, while in the northern part on Jalan Kaligawe Raya which is classified as an arterial road is dominated by industrial areas because the north part of Gayamsari Sub-district is still included in the part of the road commonly referred to as the pantura route so that many industrial factories are located along Jalan Kaligawe Raya.

The existing waste management system in Gayamsari Sub-district is under the responsibility of the Integrated Implementation Unit (UPT) 2, which is part of the Semarang City Environmental Agency (DLH). UPT 2 is responsible for the overall implementation of waste management in the Gayamsari Sub-district, starting from providing infrastructure facilities in the form of waste containers, transporting waste, and coordinating the sale of recyclable waste or scrap waste among scavengers and collectors. The number of waste storage facilities in the form of temporary disposal sites (TPS) in the Gayamsari Sub-district reaches 12 TPS. Based on field observations and interviews that have been conducted with UPT 2, the implementation of waste transportation in the Gayamsari sub-district area reaches 12 TP.

Trade and services in Gayamsari Sub-district are carried out by the private sector and transported directly to the Jatibarang Landfill (TPA) because the TPS available in Gayamsari Sub-district cannot accommodate the total waste. Waste that is directly transported to the landfill certainly does not undergo reduction first at the TPS, so the types of waste that can still be recycled are directly disposed of in the landfill, resulting in the accumulation of waste in the landfill increasing rapidly.

Based on the factual conditions in the trade and service area of Gayamsari Subdistrict, it is necessary to research and identify the amount of waste generated by activities in the trade and service area of Gayamsari Subdistrict. The use of the SNI 19-3964-1994 method in the implementation of waste collection and measurement in non-residential urban areas also aims to review whether the SNI 19-3964-1994 method is still suitable for measuring waste generation under current conditions.

This study aims to review SNI 19-3964-1994, which is a method of collecting and measuring waste generation in trade and service areas by analyzing the amount of waste generation and types of waste produced from trade and service areas in Gayamsari District and analyzing waste generation data spatially so that it can be concluded whether the SNI 19- 3964-1994 method is still suitable for use in the implementation of waste collection and measurement in urban areas, especially in non-residential areas.

This research also has a foundation from previous studies that discuss the study of waste management systems and the use of spatial analysis in autocorrelation.

Table 1. Previous Research

Author	Research Title	Research Objectives	Methods Research	Research Results
Sukarna et al., 2019	Autocorrelation Analysis of Moran'sI, Geary's C, Getis-Ord G, and LISA and its Application to Leprosy Patientsin Gowa Regency.	It aims to determine the spatial pattern of leprosy using the Quadrat Analysis method and whether there is spatial autocorrelation between regions using Moran's I, Geary's C, Getis- Ord G, and LISA and mapping—Deployment Leprosy in Gowa Regency.	- Quadrat Analysis - Global Spatial Autocorrelation (Moran's I, Geary's C) - Local Spatial Autocorrelation (LISA)	- Spatial Pattern Testing on Leprosy Patient Data in 2016 and 2017 in Gowa Regency usingthe Quadrat Analysis method is clustered. - There is autocorrelation spatial distribution ofleprosy in 2016 in Gowa Regency usingMoran's I and Geary's C methods.
Prita Puspa Noviana, 2020	Study of Waste Management System of Tourism Area in the Coastal Areaof Semarang City	It aims to assess the waste management system of tourism activities in the coastal area of Semarang City in terms of waste generation, sorting, collection, and transportationto landfill.	- Descriptive Quantitative - SNI 19-3964-1994 on Methods of Collection and Measurement of Urban Waste Generation and Composition	- Marina Beach, Baruna, PRPP Maerakaca,Tirang, and Cipta are dominated by organic waste from marine sources. - The waste managementsystem is stillunavailable at the three beaches, namely Tirang, Baruna, and Cipta.

RESEARCH METHODS

This research uses a quantitative method analysis approach. A quantitative method is an approach that is suitable for research that uses a spatial approach in the form of Moran's I because it can process data in the form of numbers, both secondary and primary data, and then the data that has been analyzed, is described into information (Firmansyah & Masrun, 2021). This descriptive quantitative research is expected to determine the existing condition of waste generation in the service trade area in the Gayamsari Subdistrict through the amount of waste generation weight, type of waste, waste composition, and location of waste generation distribution in the research area.

The data collection technique is a stage in the research process that aims to collect the required data appropriately. The selection of data collection techniques needs to be considered because it affects the validity and accuracy of the data used. Based on the type there are 2 data types in conducting a study, namely primary and secondary data (Taherdoost, 2021).

Primary data collection techniques in this study come from field observations in the form of observing trade and service areas in the research area, the location of waste generation, types of waste, and community behavior in waste management and measurements using SNI 19-3964-1994 related to methods of collection and measurement of urban waste generation and composition. Secondary data collection techniques are sourced from Government documents, journal literature reviews, and websites from highly credible institutions or agencies. Through secondary data, valid data and data related to previous research can be known to complement and improve the research results related to the waste sector that has been carried out previously (Karjoko et al., 2020).

RESULTS AND DISCUSSION

This study began with measuring waste generation referring to SNI 19-3964-1994 during an 8-day survey period with a sample of 30 shops of various types. Then, the waste generation data was produced in the trade and service area of Gayamsari District, which included ten types of waste. In the waste generation data obtained through the SNI 19-3964-1994 sampling method, the amount was 82 tons/week, with Gayamsari Market being the most significant waste producer with an amount of approximately 71 tons/week with organic waste with wet waste characteristics being the most important type of waste produced. The following is a table of waste generation data for the trade and service area of Gayamsari District.

Table 2. Results of Measurement of Emissions

Store Name	Type Waste (Kg)										TOTAL
	PE plastic	Plastic Bottle	Glass Shards	B3	White Bucket	Clan	Cans	Cardboard	Paper	Organic	
TB Manunggal Jaya	29	46	49	33	26	81	12	42	2	28	**348**
Anugrah Textile	28	24	0	0	0	22	0	17	0	88	**179**
Gayamsari Market	60	86	34	26	117	198	49	57	2	70445	**71074**
Serba Sari	19	29	0	26	46	33	0	48	0	64	**265**
Anterah	24	16	0	0	7	51	32	65	5	29	**229**
Lotte Mart	94	247	37	24	126	317	109	258	39	1197	**2448**
Indomaret Gajah Raya	42	50	0	8	44	81	26	56	20	78	**405**
Elephant Print	47	9	0	0	6	82	0	386	553	8	**1091**
Maylisa's Brownie House	35	21	0	0	8	67	0	43	0	139	**313**
SRC Jafariah	18	24	0	0	25	12	16	38	0	36	**169**
Burjo Racing	35	71	6	0	20	34	16	19	10	154	**365**
Guna Agung	81	8	0	0	0	37	0	49	0	79	**254**
Yokho Motor	41	28	19	31	58	47	21	34	3	67	**349**
Berkat Jaya Motor	29	23	0	40	73	75	31	51	19	45	**386**
Our Molen	53	21	0	36	29	61	0	38	15	71	**324**
Mugi Waras Pharmacy	23	7	0	51	8	8	0	17	14	38	**166**
Azka Grocery Store	36	35	0	0	4	28	0	16	12	86	**217**
Anteraja	69	2	0	0	0	63	0	108	48	28	**318**
Khanza Florist	24	0	0	0	0	0	0	31	40	79	**174**
Tambak Dalam Pharmacy	46	28	8	28	20	40	12	23	20	44	**269**
Jaya Mandiri	31	40	50	0	0	40	0	48	0	24	**233**
Sicepat Express	45	0	0	0	0	55	0	104	26	28	**258**
Ananda Pojok	17	37	16	0	33	55	32	40	0	102	**332**

Store Name	Type Waste (Kg)										TOTAL
	PE plastic	Plastic Bottle	Glass Shards	B3	White Bucket	Clan	Cans	Cardboard	Paper	Organic	
Jasmine Photo	10	4	0	0	0	23	0	18	68	35	**158**
OTI Fried Chicken	41	55	0	0	0	70	0	31	41	212	**450**
Duniatex	33	0	0	0	0	48	0	56	24	40	**201**
Indomaret Sawah Besar	24	40	0	0	38	61	24	49	16	77	**329**
Datanci	16	0	49	0	0	0	16	99	15	36	**231**
Kampoeng Semarang	44	59	0	0	35	127	26	151	34	401	**877**
Soto Ayam Pak Harto	38	39	0	23	21	39	2	35	17	109	**323**
Total/Type of Waste	**1132**	**1049**	**268**	**326**	**744**	**1855**	**424**	**2027**	**1043**	**73867**	
Total	**82735**										

Waste generators that contribute significantly to the amount of waste generated in the Gayamsari Sub-district are stores classified as large-scale in terms of store size and the type of goods offered. Kampoeng Semarang is a large store located on an arterial road, Jalan Kaligawe Raya, with goods sold as souvenirs that are dominated by organic goods.

Toko Gajah Print, a printing service provider, is a medium-sized store on a collector road in Jalan Gajah Raya. Still, the goods sold are paper and MMT which are produced in large quantities daily. The last is Lotte Mart, which is a wholesale store that provides daily necessities and other goods of various types, with a large store size and is located on an arterial road, Jalan Majapahit, making Lotte Mart crowded with visitors and dynamic activities so that the waste generated every day has a variety of types ranging from inorganic waste to organic waste, such as fruit and vegetable waste that is easily decomposed. These three stores have different criteria from each other but contribute a relatively large amount of waste generation due to the type of goods sold and the busy visitor activity in the store, which is the cause of the large amount of waste generated. Furthermore, the determination of the weight composition of waste was carried out, where the type of waste that gave the most significant contribution to the amount of waste generated in the trade and service area of Gayamsari District was organic waste, with a total of 89.3% or 74 tons. The type of waste with the least amount came from glass waste or broken glass, with a percentage of 0.3% or 268 kg. The average weight of waste was also measured using the method from SNI 19-3964-1994.

$$\text{Weight of Waste Generation} = Bs/u \tag{1}$$

Where Bs is the weight of measured wasted, u is the Number of waste-generating units so that the weight of the waste generated in this study becomes.

$$Bs = \frac{\left(\frac{B_{s1}}{u} + \frac{B_{s2}}{u} + \frac{B_{s3}}{u} + \cdots\cdots\cdots + \frac{B_{s30}}{u}\right)}{u} \text{ kg/store/hr}$$

$$= \frac{2747{,}1}{30} \text{ kg/store/hr}$$

$$= 91{,}6 \text{ kg/store/hr}$$

Based on the calculation of the average weight of waste generation in the trade and service area of the Gayamsari Subdistrict for each day, it reaches 91.6 kg/shop/hr. The existing types of waste are divided into three compositions: organic waste, residual waste, and recycling (scrap).

$$B_{Or} = \frac{(B_{or1}+B_{or2}+B_{or3}\cdots\cdots\cdots+B_{or30})}{u} \tag{2}$$

$$B_{Du} = \frac{(B_{Du1}+B_{Du2}+B_{Du3}\cdots\cdots\cdots+B_{Du30})}{u} \tag{3}$$

$$B_{R} = \frac{(B_{R1}+B_{R2}+B_{R3}\cdots\cdots\cdots+B_{R30})}{u} \tag{4}$$

Where B_{or} is the weight of organic waste, B_{Du} is the weight of recyclable waste, B_R is the weight of residual waste and u is the number of waste-generating units, the results are obtained from the three formulas above.

B_{or} = 73758/30 kg/store/hr
= 2458,6 kg/store/hr
B_{Du}= 5963/30 kg/store/hr
= 1988,8 kg/store/hr
B_{or} = 2691/30 kg/store/hr
= 89,7 kg/store/hr

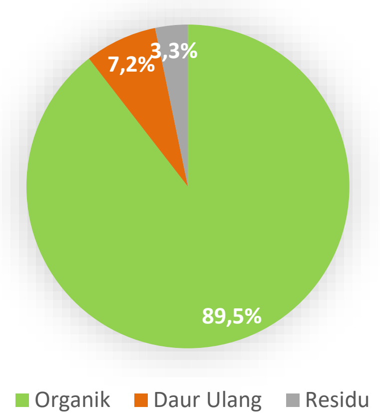

Figure 1. Diagram of Waste Percentage per Composition

After calculating the average weight of waste per type of composition, it can be seen that the waste in the Gayamsari District trade and service area is dominated by organic waste at 89.5%, recyclable or saleable waste at 7.2%, and residual waste that needs to be disposed ofat 3.3%. Organic waste is undoubtedly the type of waste that contributes the most to each waste generation due to its composition consisting of food scraps, and most cannot be recycled.

Organic waste management can only be made back into compost, which can be helpful inagriculture. In contrast, the number of types of recycled waste can be an indicator of the *circular economy*, where waste is reproduced so that it can be reused as a new product or raw material for other products to reduce waste that is harmful to the environment and health (Purwanti, 2021).

In mapping waste generation at the sample shop locations that have been determined as sources of waste generation in the trade and service areas of Gayamsari District, they are spatially distributed in the northern, central, and southern parts of Gayamsari District. They are located on arterial roads, collectors, and the environment. Determining the various locations is helpful as a representation of each type of shop and the area of the shop so that the amount of waste and the type of waste produced can be known. The following is a map of the distribution of sample shop locations in Gayamsari District.

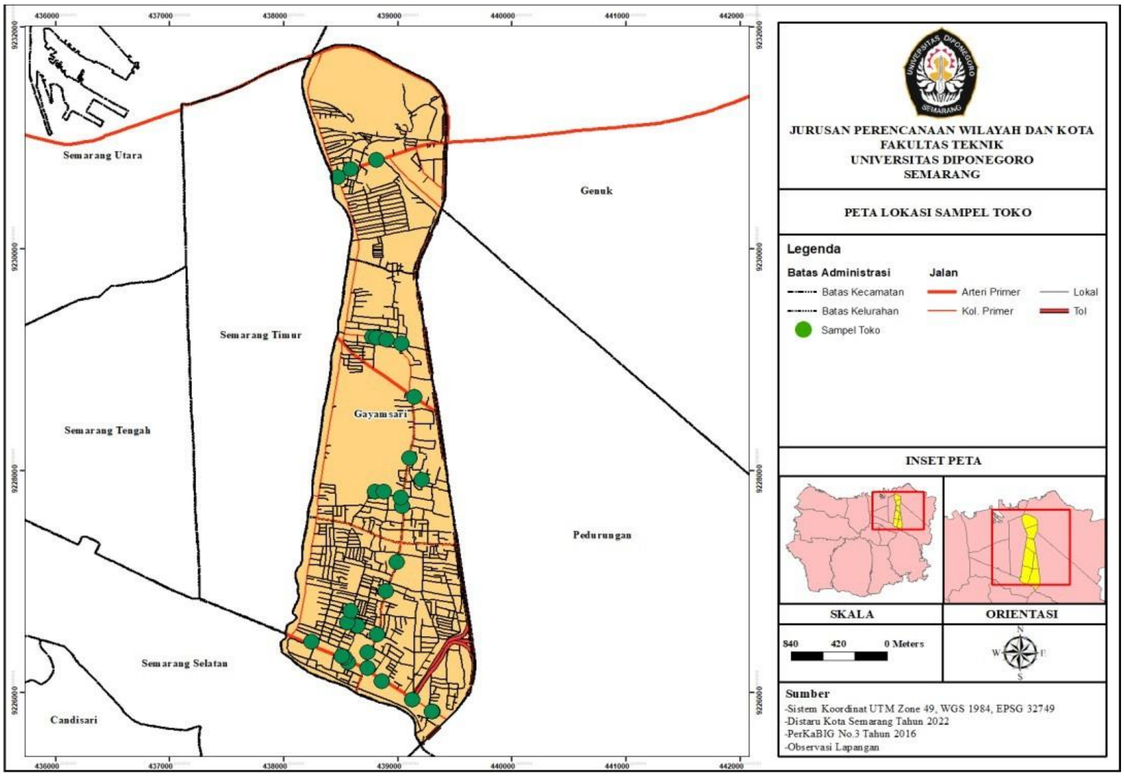

Figure 2. Map of Sample Store Locations

Furthermore, to determine the level of waste generation, the amount of waste generation is divided into three classifications: low, medium, and high. This classification of the amount of waste generation helps us to know which shops are classified as low to high waste producers, and this information can be visualized spatially on the Waste Generation Level Map. The following is a classification of the amount of waste in the trade and service areas of Gayamsari District.

Table 3. Classification Table of Waste Quantity

No.	Classification	Amount of Garbage
1	High	>500
2	Medium	300-500
3	Low	<300

The above classification is based on the average amount of waste generation so that it can meet the objectives of making data visualization in the form of mapping the classification of the level of waste. The following is a graph of the classification of waste generation in each store.

Table 4. Classification Table of Waste per Store

No.	Store Name	Amount of Garbage	Classification	No.	Store Name	Amount of Garbage	Classification
1	TB Manunggal Jaya	348	Medium	16	Mugi Waras Pharmacy	166	Low
2	Anugrah Textile	179	Low	17	Azka Grocery Store	217	Low
3	Gayamsari Market	71074	High	18	Anteraja	318	Medium
4	Serba Sari	265	Low	19	Khanza Florist	174	Low
5	Anterah	229	Low	20	Tambak Dalam Pharmacy	269	Low
6	Lotte Mart	2448	High	21	Jaya Mandiri	233	Low
7	Indomaret Gajah Raya	405	Medium	22	Sicepat Express	258	Low
8	Elephant Print	1091	High	23	Ananda Pojok	332	Medium
9	Maylisa's Brownie House	313	Medium	24	Jasmine Photo	158	Low
10	SRC Jafariah	169	Low	25	OTI Fried Chicken	450	Medium
11	Burjo Racing	365	Medium	26	Duniatex	201	Low
12	Guna Agung	254	Low	27	Indomaret Sawah Besar	329	Medium
13	Yokho Motor	349	Medium	28	Datanci	231	Low
14	Berkat Jaya Motor	386	Medium	29	Kampoeng Semarang	877	High
15	Our Molen	324	Medium	30	Soto Ayam Pak Harto	323	Medium

Based on the classification table of the level of waste and the distribution map of the level of waste, it can be seen that there are four trades and services with a high classification, 12 shops with a medium classification, and 14 shops with a low classification. Based on field observations, stores that sell organic materials or food produce considerable waste, even though the store is small.

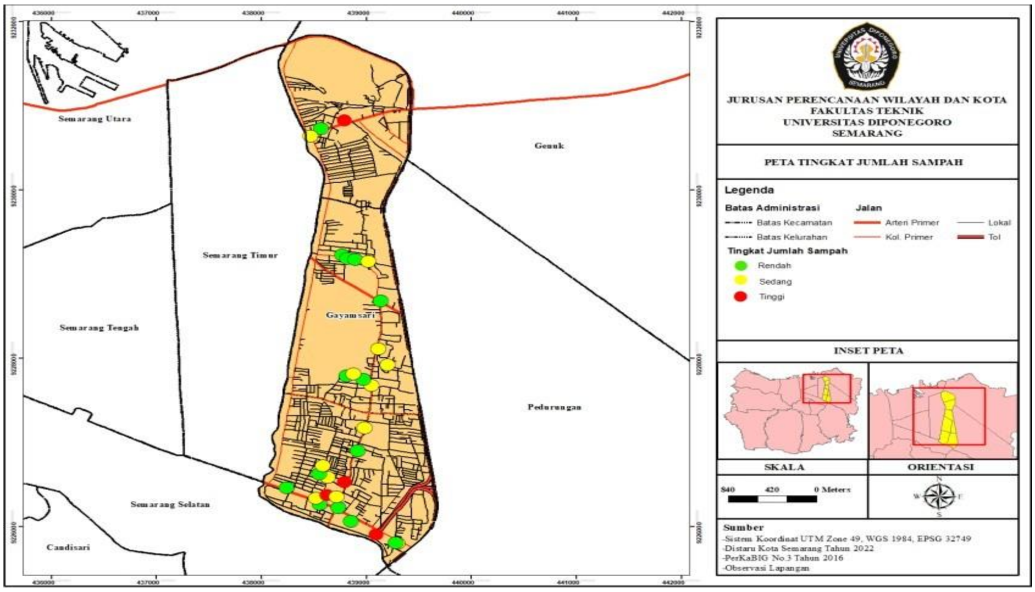

Figure 3. Map of Waste Level

The next stage is to analyze the spatial reach of the store, namely the analysis of the reach of the store's services to the surrounding environment based on the distance in meters. This service reach analysis uses a network analysis from 100 m to 500 m in a service area. The purpose of this service reach analysis per store is to determine the area reached by the nearest customers of the store so that it can be determined whether the criteria of the environment around the store (settlement) affect the amount of waste generated in each store. The following is a map of the reach of the environment around the store in the trade and service area of Gayamsari District.

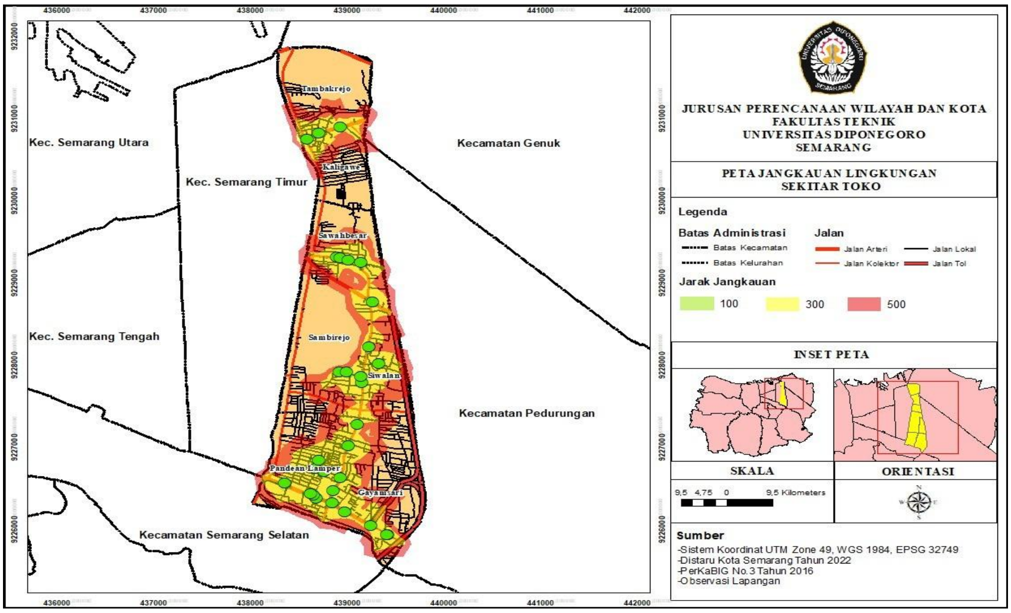

Figure 4. Store Neighborhood Reach Map

Seeing the relationship between waste generation data and criteria in the neighborhood around the store requires comparing stores of the same size but located in different residential areas. There are three criteria for the residential environment around the store: elite, medium, and MBR (Low Income Community) residential areas. These three types of residential areas are seen based on field observations. These three stores are Ananda Pojok, which is located in Jalan Tambak Dalam Raya and is included in the MBR settlement, and the Guna Agung store, which is located in Jalan Gajah Raya and is included in the medium settlement. Finally, the Indomaret minimarket on Jalan Gajah Raya is included in the elite settlement.

Based on the waste generation data that has been obtained, it shows that the Ananda Pojok store, which sells daily necessities from primary to tertiary goods, generates waste generation of 332 kg/week, the Guna Agung store, which sells plastic, generates waste of 254 kg/week. Indomaret Gajah Raya generates waste of 405 kg/week. The conclusion can be drawn that the environment around the store does not affect the amount of waste generated by the store, back to the fact that the type of goods sold involves the amount of waste, such as the Guna Agung store, which sells plastic as its main commodity, of course, cannot be compared to the Ananda Pojok store which sells a variety of goods of various types.

Furthermore, Moran's analysis is carried out as a spatial analysis in the form of autocorrelation between the sample locations used to obtain the spatial pattern of the research sample locations. This study uses Moran's I analysis to determine the form of the spatial pattern between the sample locations used. The analysis results are then compared with the existing TPS locations, aiming to determine whether the TPS in Gayamsari District can cover the trade and service areas of Gayamsari District. The background to the purpose of this study is that the party that transports waste in the trade and service areas of Gayamsari District is a third party. The implementation of Moran's I analysis uses data from field observations and surveys in the form of sample shop locations, shop coordinates, shop types, and shop names. The analysis process uses a divided research area per village so that the relationship between neighbors between locations can be determined.

```
    Moran I test under normality

data:  toko$sum
weights: ww

Moran I statistic standard deviate = 1.7592, p-value = 0.03927
alternative hypothesis: greater
sample estimates:
Moran I statistic       Expectation          Variance
       0.24411488       -0.16666667        0.05452675
```

Figure 5. Store Neighborhood Reach Map

Based on the results of the Moran's I analysis that has been carried out, it can be seen that the Moran's Index value is 0.24411488, which means H0 is rejected because I < 0, so there is a positive spatial autocorrelation between the sample store locations. The expectation value is -0.16666667, the variance value is 0.05452675, and the p-value is 0.03927; then, to find out the z-score, the calculation is done using the formula.

$$Z(I) = \frac{I - E(I)}{\sqrt{VAR(I)}} \tag{5}$$

Where Z(I) is the value of the z-score statistical test, I is the moral value of I, E(I) is the expected value, and VAR(I) is the variance value. From the formula, the results obtained are the z-score statistical test value.

$$Z(I) = \frac{0.24411488 - (-0.16666667)}{\sqrt{0.05452675}}$$

Z (I) = 1.7592

Table 5. Moran's I Significance Test Table

Moran's I	**Z(I)**	**Z(α/2)**	**Statistical Test**	**Conclusion**
0.24411488	1.7592	2.58	1.7592 < 2.58 then H0 rejected 0.24411488 > 0 then H1 accepted	Positive spatial autocorrelation & *cluster* spatial pattern shape

Looking at the value of each parameter, it can be concluded that the sample location of shops in the Gayamsari District trade and service area has positive spatial autocorrelation, and the shape of the spatial pattern is clustered.

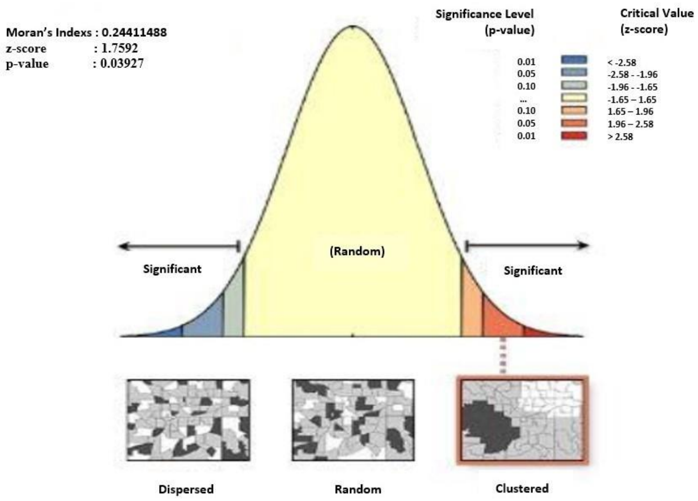

Figure 6. Moran's I Autocorrelation Figure

Moran's scatterplot shows points in quadrants I, II, III, and IV. The following is Moran's scatterplot analysis of waste generation in the trade and service area of Gayamsari Sub-district Quadrant I, HH (High-High) shows areas that have a high value or value and are surrounded by other areas that have a high observation value as well, Kelurahan Pandean Lamper is included in the quadrant I area. Quadrant II, LH (Low-High) shows that areas included in low observations but surrounded by other areas of high value, Kelurahan Tambak Rejo and Kelurahan Gayamsari, are included in quadrant II. Quadrant III, LL (Low-Low) consists of areas with low observation values and are surrounded by areas with low observation values, such as Kaligawe Village and Sawah Besar Village. Quadrant IV, HL (High-Low) is a quadrant consisting of areas with high observation values, but the surrounding areas have low observation values. The villages that fall into Quadrant IV are Sambirejo Village and Siwalan Village.

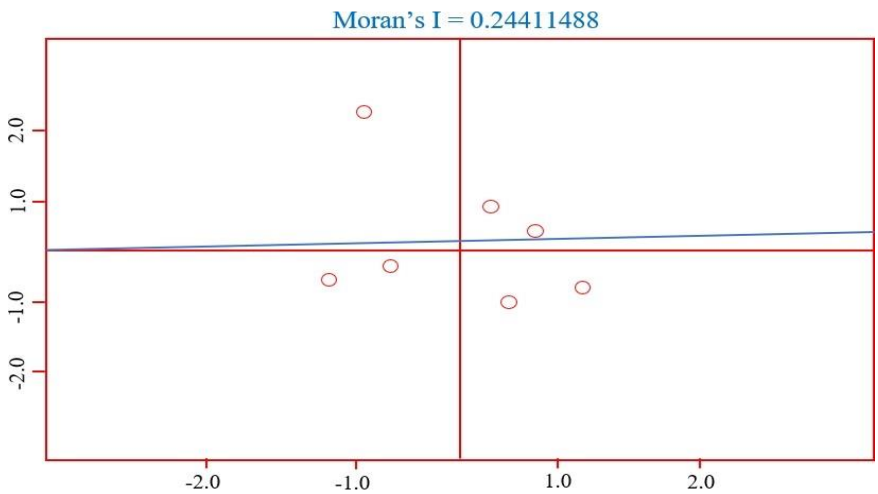

Figure 7. Moran's Scatterplot

The following compares the stages in SNI 19-3964-1994 and the stages in the research implementation.

Table 5. Moran's I Significance Test Table

No.	Research Waste GenerationSampling Stages	SNI 19-3964-1994
1.	Determination of study locations in non-residential areas, namely trade and service areas.	Determination of study locations in non- residential areas consisting of shops, offices, schools, markets, roads, hotels, restaurants, and others.
2.	The determination of shop samples was based on five criteria: street classification, shop size, type of settlement around the shop, type of shop, and charcoal sold.	The criteria for determining the sample of waste generation sources consist of road function, market function, hotel, restaurant, etc.
3.	Determining the number of sample stores used a calculation formula from best practices, which resulted in 30 sample store units from 414 store units in the study area.	The number of sample stores is determined based on the number of residents in the study area divided by the number of stores per 2300 residents.
4.	Determination period. The sampling period is, by *best practices*, for eight days.	Sampling frequency for eight days at the samelocation.
5.	Using equipment and supplies suchas plastic bags measuring 80 x 100 cm, scales with a capacity of 0-50kg, and gloves.	Using equipment such as 40-liter plastic bags, 20 cm x 20 cm x 100 cm boxes, 0-5 kg and 0-100 kg scales, shovels, and gloves.
6.	The measurement of waste generation samples was carried outin the afternoon because when the waste from the shops had all been collected during shop closing time.	None
7.	Waste generation data in the form of total weight and weight per type of waste that has been determined previously.	The data generated is the total weight and average waste generation.
8.	The calculation of the amount of waste generation resulted in the average weight of waste generation and weight per waste composition.	

CONCLUSION

This research was successfully conducted by using sampling of waste generation by SNI 19-3964-1994 concerning the collection and measurement of urban waste generation with measurement categories in non-residential locations, and using a spatial approach in the form of mapping waste generation data and analyzing spatial autocorrelation between store sample locations using Moran's I analysis. The conclusion that can be drawn from the resulting analysis is that there are still shortcomings in SNI 19-3964-1994, especially in the operational part of measuring and sampling waste generation. The weakness of SNI 19-3964-1994 is the lack of explanation in determining the criteria for storing samples based on the function and type used. The equipment in the implementation stage is challenging to use due to limited time and personnel for measuring and sampling. SNI 19-3964-1994 does not explain the best time to collect waste in the morning, afternoon, evening, or night. However, in the calculation formula for determining the sample of research shops, the number of sample shops used can already represent or become a representation of one trade and service area of Gayamsari Subdistrict, seeing from the results of waste generation data that has been obtained has a variety of types and composition of waste generation. Through this research, it is hoped that it can be helpful for Government agencies, especially the Semarang City Environment Agency, in improving waste service infrastructure and increasing and improving the waste management system. It can be helpful for fellow academics in research in the field of waste so that, hopefully, it can find innovations in planning and waste management in urban areas, and hopefully, it can be helpful in the community who acts as one of the stakeholders who can participate in the course of this waste management.

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