COMSERVA: Jurnal Penelitian dan Pengabdian Masyarakat
e-ISSN: 2798-5210
p-ISSN: 2798-5652
Volume 6 No. 3 July 2026

Quantitative Analysis of Coffee Shop Operational Waste Using Python

Adyaraka Banyu Langit*, Rai Ikhsan Wiratama
Nizamia Andalusia School, Indonesia
Email: banyulangitadyaraka@gmail.com*, nizamiahighschool2023@gmail.com

Keywords:
descriptive statistics; operational waste; coffee shop; Python; data analysis

ABSTRACT

This research analyzed 13 months of daily operational waste data from a coffee shop in Jakarta, Indonesia, covering the period from January 2024 to January 2025. The data were collected from bar and kitchen operations across five waste categories: bar non-organic waste, bar organic waste, bar coffee grounds (ampas kopi), kitchen non-organic waste, and kitchen organic waste. This research employed a quantitative descriptive approach using secondary data from daily waste records to identify and summarize waste generation patterns without manipulation or intervention. After the data were loaded and organized using Microsoft Excel, descriptive statistics were calculated to identify patterns in daily waste generation. The results showed that the mean total daily waste was 14.46 kg, with a median value of 11.90 kg. A substantial reduction in waste generation was observed between the first three months (January to March 2024), which averaged 24.0 kg/day, and the remaining period, which averaged 12.0 kg/day, indicating improved operational efficiency over time. Organic waste accounted for 41.2% of total waste, while non-organic waste accounted for 58.8%. The two kitchen waste categories demonstrated a strong correlation (r = 0.659), indicating that they tended to increase and decrease simultaneously. No significant differences in waste generation were identified across days of the week (p = 0.903). This research demonstrates that basic data analysis using Python can transform simple daily operational records into valuable insights for business planning and waste management improvement.

INTRODUCTION

Every day, coffee shops generate operational waste from both bar and kitchen activities, including coffee grounds, food scraps, and non-organic packaging (Berno, 2024; Hansen, 2026; Wanlie, 2022). Although many coffee shops record waste data, these records are rarely analyzed systematically. Without proper analysis, it is difficult to determine typical daily waste generation, identify variations across months, or recognize patterns that may support operational improvements (de Morais et al., 2024; Priyanka et al., 2025; Singh et al., 2024).

This research examined one year of daily waste records from a single coffee shop in Jakarta, Work Coffee Indonesia (Alfarizi et al., 2023; Aprilia et al., 2023; Berno, 2024; Istighfarani, 2025; Kurnianto & Ardillah, 2025; Wanlie, 2022; Waskita et al., 2024). The data were collected from January 2024 to January 2025 and covered five waste categories. The objective was to apply Python-based data processing and analysis to clean, organize, and identify waste generation patterns that could support improved decision-making in waste management and operational planning.

Food service waste has become a growing concern in both global and Indonesian contexts (Adhariani, 2024; Farahdiba et al., 2023; Waluyo & Kharisma, 2023). Globally, the food service sector contributes approximately 14% of total food waste, while in Indonesia, food waste accounts for 39.87% of national waste, reaching nearly 20 million tons in 2024, with estimated annual economic losses of IDR 200–551 trillion (Walina, 2022; ANTARA News, 2025; Martino, 2024). Previous studies on Indonesian coffee shops have examined circular economy approaches, with Nazwa et al. (2025) finding that upcycling partnerships can process 1.8–3.5 tons of waste monthly into products such as eco-bags and coffee soap. Meanwhile, Laili et al. (2024) reported that only 15%–20% of solid waste is effectively valorized due to limitations in technological knowledge and market access. Research on coffee shop entrepreneurs has also shown that owner awareness, strongly influenced by waste management knowledge (93.6%), contributes to improved waste sorting and conversion practices (Alfarizi et al., 2023).

Beyond coffee shops, research on Indonesian food service establishments has focused on waste characterization and management strategies. Chaerul et al. (2025) found that all-you-can-eat restaurants in Bandung generated 0.74 kg/consumer/day of waste, with food waste accounting for 55.74%, and recommended centralized composting approaches. Studies of university canteens reported lower waste generation rates of 0.019–0.021 kg/person/day, with recommendations including awareness campaigns and composting initiatives (Universitas Riau, 2025). Spatial research in Malang revealed that coffee shops operate for 7–12 hours daily using both reusable and disposable packaging, with some adopting environmentally friendly practices such as steel straws and cup reuse programs (Nurani et al., 2021). However, a research gap remains in the quantitative analysis of daily waste generation patterns specifically within coffee shop operations using accessible programming tools such as Python, as existing studies have largely relied on qualitative approaches or focused on larger food service establishments.

Despite the growing body of literature, several research gaps remain. First, existing studies on coffee shop waste management in Indonesia have predominantly employed qualitative methods, including interviews, case studies, and thematic analysis, to explore circular economy practices and entrepreneur perspectives (Alfarizi et al., 2023; Nazwa et al., 2025). Quantitative studies that systematically analyze daily waste generation patterns based on objective measurement data remain limited. Second, studies applying quantitative approaches in food service contexts have generally focused on larger establishments, such as restaurants and university canteens (Chaerul et al., 2025; Walina, 2022), with limited attention to the operational characteristics of coffee shops, where waste streams from beverage preparation (bar) and food preparation (kitchen) are combined. Third, although descriptive statistics are widely applied in Indonesian research, limited studies have demonstrated their application to operational waste datasets using contemporary programming tools such as Python, which provide advantages in reproducibility and accessibility compared with proprietary analytical software.

This research was guided by three main questions: (1) What is the average daily waste generation for each category? (2) Are there identifiable patterns across months or days of the week? and (3) How can the findings support improved waste management planning? In addition, the analysis examined relationships among waste categories and assessed the distribution characteristics of the dataset. All analyses were conducted using Python through Jupyter Notebook and Microsoft Excel, supported by the pandas, NumPy, matplotlib, seaborn, and SciPy libraries.

The novelty of this research lies in addressing the limited quantitative analysis of waste generation specifically in Indonesian coffee shops, where beverage and food preparation waste streams converge within a distinct operational environment. Methodologically, this study contributes by applying Python-based analysis to operational waste management using open-source tools for descriptive statistical analysis, thereby reducing analytical costs and improving reproducibility for small businesses. The 13-month longitudinal dataset also provides an important contribution because many food service waste audits are limited to short-term observations of one to two weeks (Chaerul et al., 2025; Walina, 2022). This extended observation period enables the identification of temporal patterns, operational adaptation effects, and stabilization trends. Furthermore, this research demonstrates how digital records maintained by Indonesian small businesses after the COVID-19 pandemic can be transformed from administrative documentation into actionable business intelligence through accessible analytical methods.

The objectives of this research were to calculate descriptive statistics for five waste categories, identify temporal patterns in waste generation, examine relationships among waste categories using correlation analysis, evaluate the consistency and predictability of each waste stream, and demonstrate a reproducible analytical workflow combining Microsoft Excel and Python. The benefits of this research extend to several stakeholders. For the coffee shop, the findings provide evidence-based insights for establishing realistic waste baselines, developing composting initiatives, simplifying monitoring through correlated waste categories, and improving operational planning. For the coffee shop industry, this research offers an accessible framework and benchmark for data-driven waste management. For environmental sustainability, it supports waste diversion strategies considering the substantial proportion of organic waste (41.2%). For academic purposes, it provides a practical case study for applied statistics education. For policymakers, it contributes sector-specific waste generation information that may support municipal waste management planning in rapidly developing urban areas such as Jakarta.

Descriptive statistics are analytical methods used to summarize and describe datasets. Rather than predicting outcomes, these methods provide an overview of data characteristics and distribution patterns. Common descriptive measures include the mean, median, and mode. According to Kaur, Stoltzfus, and Yellapu (2018), these measures provide complementary perspectives on the central tendency of a dataset.

The mean represents the average value of all observations and is useful for datasets without extreme outliers. The median represents the middle value after data are arranged in order and is more appropriate when extreme values may influence the average. The mode identifies the most frequently occurring value within a dataset. Ali, Bhaskar, and Sudheesh (2019) noted that when the mean is substantially higher than the median, the dataset may exhibit positive skewness due to several unusually large values increasing the average.

Standard deviation measures the extent of variation around the mean. A lower standard deviation indicates that observations are relatively close to the average, whereas a higher standard deviation reflects greater fluctuations. Channawar (2023) emphasized that understanding data variability is essential because highly fluctuating waste generation patterns may reduce the usefulness of average values for operational planning.

The application of descriptive statistics in waste management and food service operations has received increasing attention in research. Harbison and Simmons (2024) highlighted that descriptive statistics remain valuable analytical tools across applied fields because their results can be interpreted without advanced statistical expertise. In food service waste management, the ability to estimate average daily waste generation, identify typical and abnormal production levels, and visualize trends over time can directly support operational decision-making.

In Indonesia, the digitalization of small business records has accelerated following the COVID-19 pandemic, creating new opportunities for data-driven analysis. Siregar (2025) emphasized that descriptive statistics serve as an important foundation for data literacy and practical problem-solving across various applied research fields. This research applies that perspective by using coffee shop waste records as a real-world dataset to demonstrate the application of descriptive statistical methods through contemporary programming tools.

METHOD

Research Context and Scope

This study employed a quantitative descriptive design using operational waste data from Work Coffee Indonesia, a coffee shop in Jakarta. Daily waste records were collected from January 2024 to January 2025, resulting in 396 daily observations over a 13-month period. Waste generation was recorded in five categories: bar non-organic waste, bar organic waste, bar coffee grounds, kitchen non-organic waste, and kitchen organic waste. All measurements were recorded in kilograms.

Data collection was conducted through direct daily measurements by coffee shop staff, with the records stored in monthly Microsoft Excel worksheets. Before analysis, the dataset underwent data cleaning to address several quality issues, including inconsistent column naming across monthly sheets, missing values from incomplete recordings, incorrect data format conversions in Excel, extreme values caused by data entry errors, and variations in row structures between earlier and later monthly records. These issues were resolved through data preprocessing using Microsoft Excel to ensure data consistency and accuracy before further analysis.

Data Analysis

All analysis was done in Python 3 using Jupyter Notebook. The library *pandas* was used to load and organize the data, *numpy* for calculations, *matplotlib* and *seaborn* for graphs, and *scipy* for statistical testing. Descriptive statistics (mean, median, mode, standard deviation, minimum, and maximum) were calculated for each waste category and for total daily waste. Monthly totals and daily averages were grouped by month. Pearson correlation coefficients were calculated between all five waste categories to see how they relate to each other. A Kruskal-Wallis test was used to check if waste levels differ across days of the week. This test was chosen over a regular ANOVA because the data is not normally distributed.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1 shows the descriptive statistics for each waste category and for total daily waste.

Table 1. Descriptive Statistics of Daily Waste per Category (kg)

Category	Mean	Median	Mode	Std. Dev	Min	Max
Bar Non-Organic	2.73	2.00	1.5	2.11	1.0	15.0
Bar Organic	2.02	1.90	1.5	1.11	0.9	13.0
Bar Kopi	2.93	2.80	3.0	2.05	0.9	31.0
Dapur Non-Organic	2.95	2.30	2.0	1.71	1.0	15.0
Dapur Organic	3.92	3.10	3.0	2.06	1.5	19.0
Total Waste	14.46	11.90	10.7	6.44	7.4	52.0

Source: Author's data analysis (2025) using daily waste records from Work Coffee Indonesia, January 2024–January 2025

Dapur organic is the largest single category, averaging **3.92 kg/day**, followed by dapur non organic (2.95 kg/day) and bar kopi (2.93 kg/day). For total waste, the mean is **14.46 kg/day** but the median is only **11.90 kg/day**. This difference tells us the data is skewed, meaning a few high-waste days in the early months are pulling the average up. For practical planning, the median of 11.90 kg is a more realistic estimate of a typical day.

Bar organic has the most consistent output across the year, with the lowest standard deviation (1.11) of all categories, meaning its daily values stay closest to its average. Bar kopi appears stable based on its median (2.80) but its standard deviation of 2.05 is inflated by a single entry of 31.0 kg, which is almost certainly a data entry error where 3.1 was typed as 31.0. Dapur non-organic has the widest range among the individual categories, reaching a maximum of 15.0 kg against a mean of just 2.95 kg, suggesting some kitchen days produced significantly more waste than usual.

Monthly Trends

Table 2 shows the total and average daily waste for each month. Figure 1 shows this as a line graph, and Figure 2 breaks the monthly totals down by category.

Table 2. Monthly Total and Average Daily Waste (kg)

Month	Total Waste (kg)	Avg Daily Waste (kg)	Organic (kg)	Non-Org (kg)
January 2024	872.20	28.14	330.90	425.90
February 2024	693.77	22.38	294.77	307.70
March 2024	672.60	21.70	295.80	265.80
April 2024	487.20	16.80	219.80	150.20
May 2024	391.00	12.61	159.40	145.00
June 2024	365.85	11.80	150.55	128.10
July 2024	353.60	11.41	144.00	122.90
August 2024	313.40	10.81	135.60	105.00
September 2024	330.50	10.66	120.60	127.80
October 2024	303.90	9.80	142.80	115.70
November 2024	349.62	11.28	143.20	120.12
December 2024	344.80	11.12	131.80	128.10
January 2025	320.40	11.44	117.80	107.50
Average	446.1 kg/month	13.65	-	-

Source: Author's data analysis (2025) using daily waste records from Work Coffee Indonesia, January 2024–January 2025

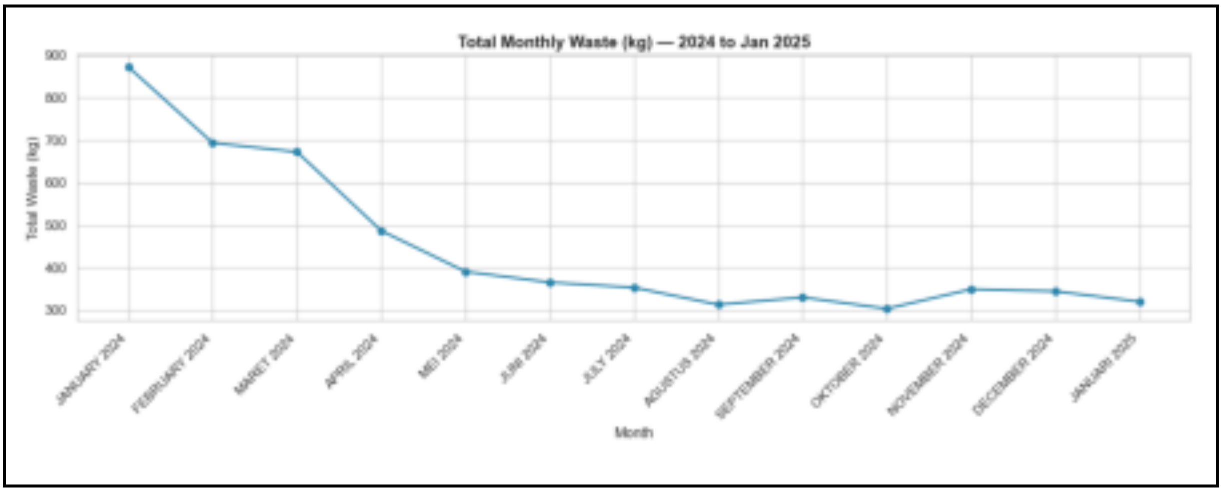

Figure 1. Total Monthly Waste (kg), January 2024 to January 2025.
Source: Author's data analysis (2025) using Python (matplotlib) based on daily waste records from Work Coffee Indonesia

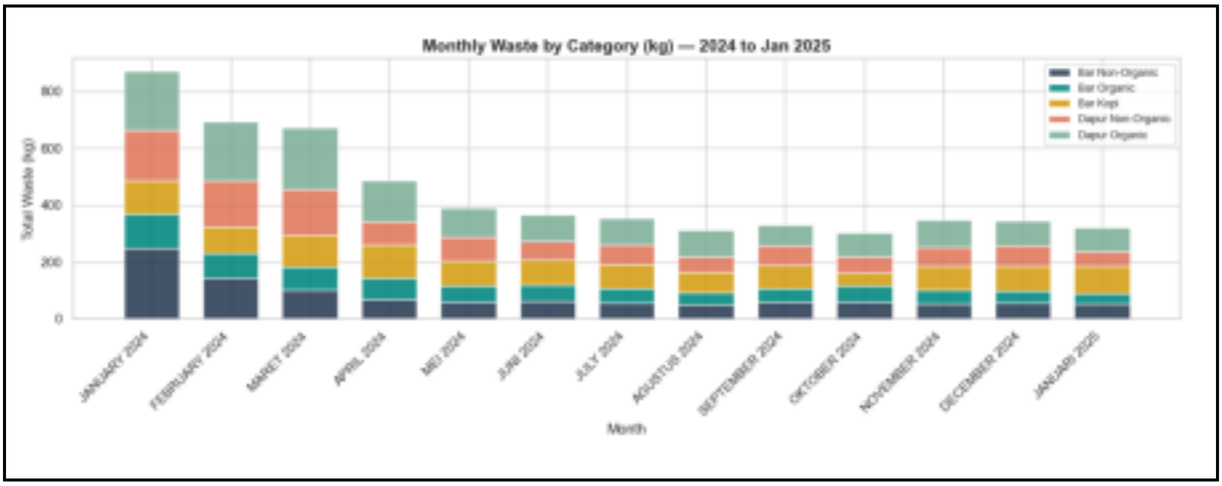

Figure 2. Monthly Waste Composition by Category (kg).
Source: Author's data analysis (2025) using Python (matplotlib) based on daily waste records from Work Coffee Indonesia

The data shows a clear drop in waste from the start of the year to around April or May 2024. In January 2024, the shop produced **872.20 kg** total that month, with a daily average of **28.14 kg**. By October 2024, this had dropped to **303.90 kg** total (**9.80 kg/day**), the lowest month in the dataset. That is a reduction of about **65%** from peak to lowest.

This trend most likely reflects the shop settling into its operations. In the early months, staff may have been over-ordering ingredients, preparing more food than needed, or still working out portion sizes. As the months went on, these processes became more efficient, and waste stabilized at a lower and more predictable level. From May 2024 onward, daily averages stayed between 9.80 and 12.61 kg, which is a much narrower range. The stacked bar chart (Figure 3) shows that this drop was spread across all five categories, not just one, which confirms it was a general operational change rather than one specific issue.

One important question this trend raises is whether the drop in waste reflects the shop becoming more efficient, or whether it reflects a decline in customer volume. Both explanations are consistent with the data. If the shop improved its waste management over time, by ordering less, preparing smaller quantities, and portioning more carefully, that would reduce waste across all five categories proportionally, which is exactly what the data shows. On the other hand, fewer customers would also mean less coffee made, less food prepared, and less packaging used, producing the same proportional drop across all categories.

What makes this harder to dismiss as purely an efficiency story is the broader context. If waste levels were already high in 2022 and 2023 before declining further in 2024, a three-year downward trend is harder to explain through operational learning alone. Most of the learning and adjustment in a new business tends to happen within the first six to twelve months. A decline that continues across multiple years is more consistent with a gradual reduction in customer traffic than with ongoing efficiency improvements. However, since this dataset only covers 2024, and since waste records alone do not contain any information about sales volume or customer count, it is not possible to confirm either explanation from this data. The most accurate conclusion is that both factors are likely contributing, and the only way to separate them would be to compare the waste figures against the shop's transaction records or daily sales data.

Waste Composition

Across the full year, **41.2%** of total waste was organic (bar organic + dapur organic) and **58.8%** was non-organic. Looking at individual categories, dapur organic was the biggest at **27.1%** of total waste, followed by dapur non-organic (20.4%), bar kopi (19.4%), bar non-organic (19.1%), and bar organic (14.0%).

The high proportion of dapur organic waste makes sense since kitchen work involves fresh ingredients where some amount of scraps and trimmings is unavoidable. Bar kopi is also a significant portion at 19.4%. Coffee grounds are produced every single day at a consistent volume, averaging 2.93 kg/day with a mode of 3.0 kg. This consistency makes kopi waste a good candidate for a recycling or composting program, since the shop can reliably predict how much will be available each day.

Correlations Between Waste Categories

Figure 3 show how the five waste categories relate to each other.

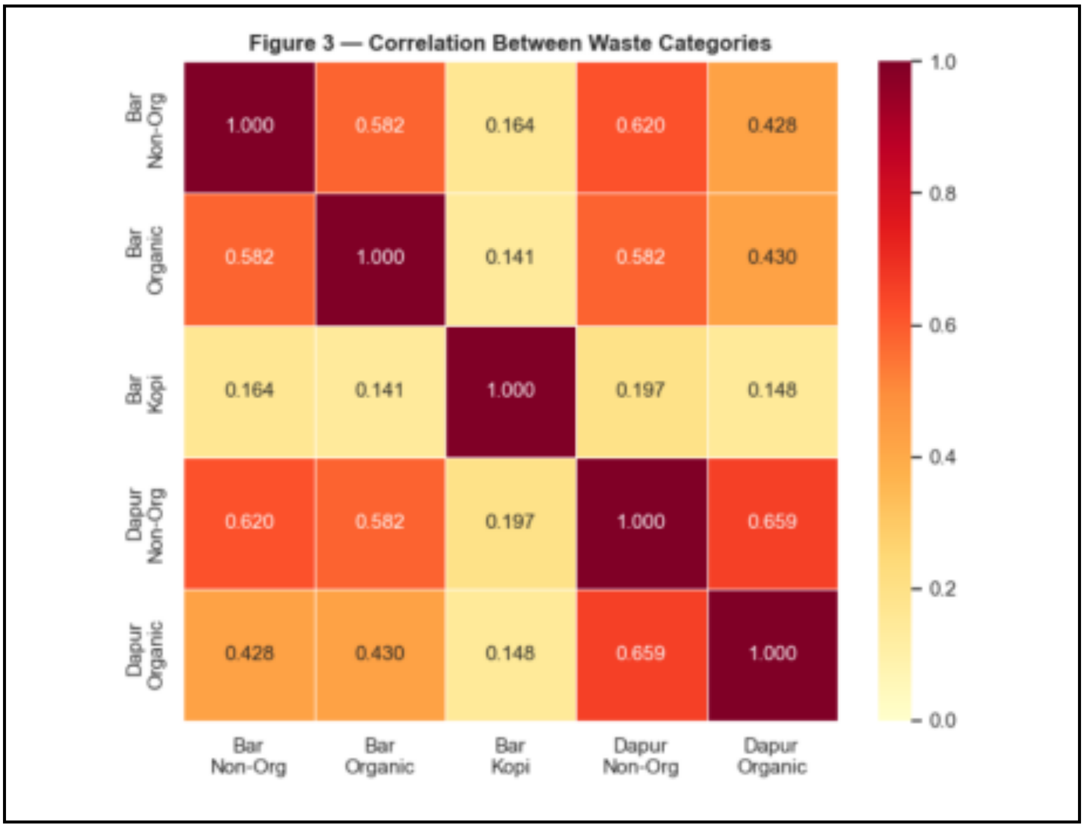

Figure 3. Pearson Correlation Matrix of Daily Waste Categories.
Source: Author's data analysis (2025) using Python (seaborn) based on daily waste records from Work Coffee Indonesia

The strongest relationship in the data is between dapur non-organic and dapur organic waste (r = **0.659**). This is a strong positive correlation, meaning when one goes up the other tends to go up too. The most likely explanation is that both types of kitchen waste are driven by the same thing: how busy the kitchen is on any given day. A busy kitchen day produces more of everything, organic and non-organic alike.

Bar kopi has the weakest correlations with all other categories (r = **0.141 to 0.197**). This suggests that coffee production volume is somewhat independent from the rest of the shop's activity. The shop could have a very food-heavy day without necessarily making more coffee, and vice versa. The moderate correlations across bar and dapur categories (around r = 0.4 to 0.6) suggest that overall business volume does drive all waste types to some degree, but the bar and kitchen do not always peak at the same time.

Day of Week Analysis

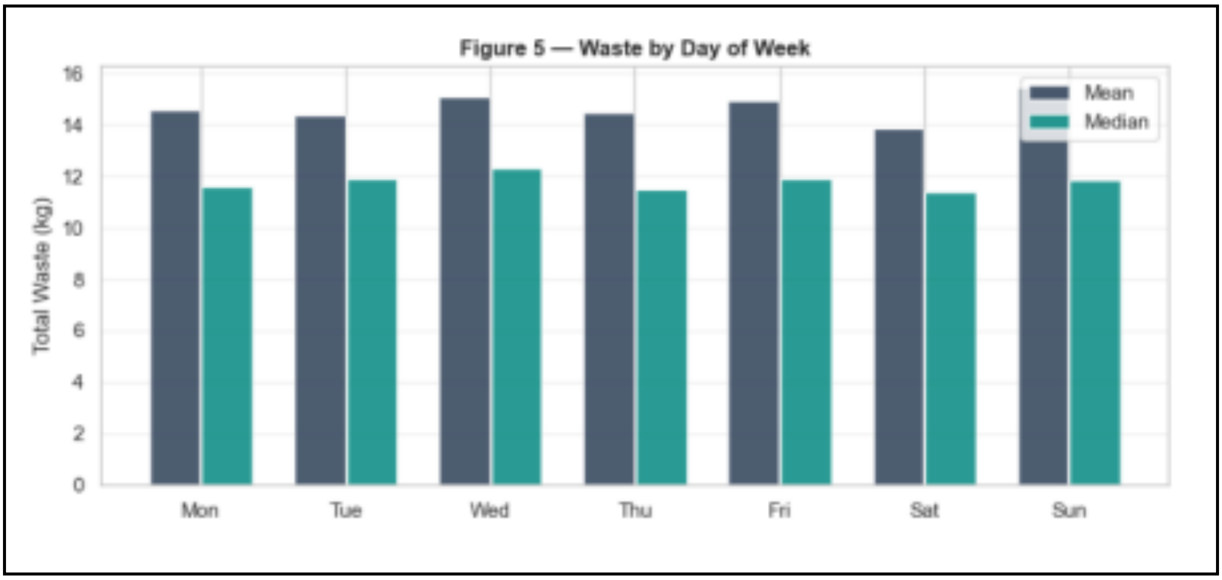

Figure 4. Mean and Median Total Waste by Day of Week
Source: Author's data analysis (2025) using Python (matplotlib) based on daily waste records from Work Coffee Indonesia

Figure 4 shows mean and median waste for each day of the week. The differences are very small: Sunday had the highest mean (about 14.96 kg) and Saturday the lowest (about 14.14 kg). The Kruskal-Wallis test confirmed that these differences are not statistically significant ($H = 2.173$, $p =$ **0.903**). This means waste production does not meaningfully change between weekdays and weekends.

This is actually useful information for planning. It means the shop does not need to adjust its waste management approach for different days of the week. A single daily estimate applies across all seven days.

CONCLUSION

This research analyzed 13 months of daily operational waste data from Work Coffee Indonesia using Python, applying descriptive statistical analysis to five waste categories across 396 daily observations. The findings revealed that the average total daily waste generation was 14.46 kg, while the median value of 11.90 kg provided a more representative estimate for planning due to data skewness caused by unusually high waste generation during the early months. A substantial reduction in waste generation occurred from January 2024 (28.14 kg/day) to October 2024 (9.80 kg/day), with waste levels stabilizing between 10–13 kg/day from May 2024 onward, indicating improved operational consistency over time. Kitchen organic waste was the largest waste category, accounting for 27.1% of total waste, while organic and non-organic waste contributed 41.2% and 58.8%, respectively. Kitchen waste categories demonstrated a moderate correlation ($r = 0.659$), suggesting potential for simplified monitoring, while bar coffee grounds represented the most consistent waste stream and showed potential for composting initiatives. No significant differences in waste generation were identified across days of the week ($p = 0.903$), indicating that daily adjustments in waste planning were unnecessary. This research demonstrates that combining Microsoft Excel records with Python-based analysis through Jupyter Notebook provides an accessible and effective approach for transforming operational data into actionable business insights, with data cleaning, statistical analysis, and visualization techniques applicable to practical data science implementation.

Based on these findings, the coffee shop should prioritize the development of a composting program for bar coffee grounds due to their consistency and volume, implement routine monthly waste monitoring to maintain operational improvements, and consider integrating daily sales data with waste records to distinguish between efficiency improvements and fluctuations in customer demand. Such integration would provide more accurate insights for inventory management. Future research should expand the analysis to multiple coffee shop locations, incorporate qualitative interviews with staff to explore waste reduction practices, and develop predictive models for waste generation based on sales data to support proactive ordering and portion control decisions.

REFERENCES

Adhariani, D. (2024). Surplus Indonesia: Tackling food waste through app. *Emerald Emerging Markets Case Studies*, 1–25.

Alfarizi, M., Samputra, P. L., & Arista, N. I. D. (2023). Role of entrepreneur's perspective of waste management for coffee shop sustainability. *Problems and Perspectives in Management*, *21*(4), 502.

Ali, Z., Bhaskar, S. B., & Sudheesh, K. (2019). Descriptive statistics: Measures of central tendency, dispersion, correlation and regression. Airway, 2(3), 120-125. https://doi.org/10.4103/ARWY.ARWY_29_19

Aprilia, A., Laili, F., Setyowati, P. B., Salsabilah, A. R., & Armasari, I. I. (2023). Sustainable business performance for local business development: Evidence from Indonesia coffee shops. *Habitat*, *34*(1), 23–37.

Berno, T. (2024). Food and sustainability: Critical reflections on food, tourism, and the SDGs. In *The Elgar companion to tourism and the sustainable development goals* (pp. 211–230). Edward Elgar Publishing.

Channawar, S. (2023). Descriptive statistics: Significance and uses of measures of central tendency: Mean, median, mode. In Introduction to Research Methodology in Education (pp. 182-202). https://doi.org/10.13140/RG.2.2.17254.52804

de Morais, C. S., Ramos, T. R. P., Lopes, M., & Barbosa-Póvoa, A. P. (2024). A data-driven optimization approach to plan smart waste collection operations. *International Transactions in Operational Research*, *31*(4), 2178–2208.

Farahdiba, A. U., Warmadewanthi, I., Fransiscus, Y., Rosyidah, E., Hermana, J., & Yuniarto, A. (2023). The present and proposed sustainable food waste treatment technology in Indonesia: A review. *Environmental Technology & Innovation*, *32*, 103256.

Hansen, N. (2026). *Building a Sustainable Kitchen: A Journey to a Climate-Conscious Dinner Table*. TouchWood Editions.

Harbison, L., & Simmons, K. (2024). Fundamentals of descriptive statistics. Journal of Dental Hygiene, 98(5), 51-54. https://jdh.adha.org/content/98/5/51

Istighfarani, S. (2025). Analyzing the environmental readiness of coffee shop entrepreneurs: A study using the PLS-SEM approach and the theory of reasoned action. *EcoProfit: Sustainable and Environment Business*, *3*(1), 17–32.

Kaur, P., Stoltzfus, J., & Yellapu, V. (2018). Descriptive statistics. International Journal of Academic Medicine, 4(1), 60-63. https://doi.org/10.4103/IJAM.IJAM_7_18

Kurnianto, G. W., & Ardillah, R. T. (2025). Study Time at the Coffee Shop: Exploring Student Motives through a Phenomenological Study. *Indonesian Psychological Research*, *7*(1), 43–54.

Priyanka, E. B., Vijayashanthy, S., Thangavel, S., Anand, R., Bhavana, G. B., Khan, B., Jeyanthi, K., & Ambikapathy, A. (2025). Prediction of waste generation forecast and emission potential on the Erode City solid waste dump yards based on machine learning approach. *Scientific Reports*, *15*(1), 37021.

Singh, T., Naik, A., & Uppaluri, R. V. S. (2024). Characterization of municipal solid waste generation and seasonal classification for various socio-demographic groups in Guwahati city. *Journal of Material Cycles and Waste Management*, *26*(2), 1210–1230.

Waluyo, & Kharisma, D. B. (2023). Circular economy and food waste problems in Indonesia: Lessons from the policies of leading Countries. *Cogent Social Sciences*, *9*(1), 2202938.

Wanlie, X. (2022). *Industrial Training Report Hot Kitchen at Latar Ijen Resto and Cafe*.

Waskita, G. S., Ashari, D. R. W., Al Haris, M. B., Rifa'i, A., & Eldon, M. (2024). Integrating sustainable development goals into coffee shop operations: Insights from Kedai Kosim, Indonesia. *SINDA: Comprehensive Journal of Islamic Social Studies*, *4*(3), 243–252.