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ASSESSING WASTE GENERATION PATTERNS IN BOI INDUSTRIAL ZONES IN SRI LANKA USING A CORRELATION APPROACH

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Effective waste management is important to achieving the United Nations Sustainable Development Goals (SDGs), particularly in industrial settings where waste generation is significant. Various studies in Sri Lanka have identified environmental issues caused by industrial waste and emphasized the need for more understanding of industry-specific waste generation patterns for effective waste management. Therefore, the identification of a correlation between industrial concentration in selected areas and the types of waste generated across different industrial sectors should be vital. The objectives of this study were to analyze the correlation between the number of industrial establishments and the amount of waste generated under various categories in Board of Investment (BOI) industrial zones and to trace the trends of waste generation by industrial type and category. Data on the number of industrial operations and waste quantities categorized as solid waste, fabric waste, biodegradable waste, treatment plant sludge, in-house treatment plant sludge, hazardous waste, and other waste were collected from official BOI databases and analyzed using Spearman's correlation coefficient to assess the relationships. The analysis reported strong positive correlations between the number of industries and multiple waste categories, notably hazardous waste ($r = 0.87$), in-house treatment plant sludge ($r = 0.78$), and biodegradable waste ($r = 0.75$). These results indicate that, in the studied industrial zones, higher industrial concentration is closely associated with increased and more complex patterns of waste generation. A particularly strong correlation between in-house sludge and hazardous waste ($r = 0.90$) highlights the complex nature of industrial waste streams, which generally contain both hazardous and non-hazardous components due to diverse production and treatment processes. Also, solid waste reported a high correlation with biodegradable waste ($r = 0.91$), emphasizing the significant organic matter fraction within industrial solid waste. It also identified fabric waste as closely linked to hazardous and other waste types, suggesting that industries producing fabric waste tend to generate diverse and potentially harmful substances. Conversely, weaker correlations between treatment plant sludge and fabric or other waste categories suggest the need for distinct management pathways for sludge. The findings emphasize the interconnected nature of industrial waste categories and highlight the necessity of integrated waste management approaches.

Keywords: industrial waste, waste generation patterns, Spearman's correlation, BOI zones, Sri Lanka

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INTRODUCTION

Effective waste management is vital for the fulfilment of the United Nations Sustainable Development Goals (SDGs). It links with SDGs of Good health and well-being (SDG 03)**,** Ensuring clean water and sanitation (SDG 06)**,** and fostering sustainable industrialization and innovation (SDG 09)**.** Efficient waste management plays a prominent role, especially in industrial settings (Fatimah et al., 2020).

Various studies in Sri Lanka have identified environmental issues caused by industrial waste. For instance, the environmental assessment of solid waste in the "Koggala" export processing zone (Abeysooriya et al., 2024) reveals the types of waste generated within export zones and the need for better management procedures. Likewise, the evaluation of environmental and economic performances of three selected textile factories in "Biyagama" Export Processing Zone examines both environmental impacts and economic performance of textile factories, underlining the interconnectedness between industrial activity, waste generation, and resource consumption (Shiwanthi et al., 2018). These studies emphasize the need for more understanding of industry-specific waste generation patterns for effective waste management in Sri Lanka. Therefore, the identification of a correlation between industrial concentration in given areas and the types of waste generated across different industrial sectors will be needed.

The specific objectives of this research were to analyze the correlation between the number of industrial establishments and the amount of waste generated under various categories and to trace the trends of waste generation by industrial type and category, and particularly which industries are the largest contributors to specific categories of waste.

METHODOLOGY

Data collection

The study was conducted to assess the relationship between the number of industries and the quantity of various categories of waste generated by the Board of Investment (BOI) regulated industrial zones. Data on the number of industries and the amount of waste generated by different industries (measured in metric tons) were obtained from the official database maintained by the BOI head office in Colombo, Sri Lanka.

Data analysis

To identify the interrelationships between the number of industries and the quantities of different types of waste generated, a correlation analysis was performed. The statistical analysis was carried out using Minitab 21.4 statistical software. A Spearman's correlation coefficient was applied for the correlation analysis, as the data did not completely meet the normality assumption required for parametric tests.

RESULTS AND DISCUSSION

The Spearman correlation analysis, depicted in Table 01 for the industrial waste generation data across multiple Board of Investment (BOI) industrial zones in Sri Lanka, indicates strong relationships among various waste types and the number of industries in operation. The number of industries operating in a zone exhibited strong positive monotonic correlations with most categories of waste generated, as depicted in Figure 01.

According to the results, a strong positive correlation was observed between the number of industries and hazardous waste generation ($r = 0.87$), which suggests that as the number of industries increases, the quantity of hazardous waste produced also increases significantly This is in line with previous studies such as Chaaban, (2001), when industrial processes generally contribute to hazardous waste production through the use of chemicals, solvents, and by-products of industrial processes.

A high positive correlation was reported between the number of industries and in-house sludge generation ($r = 0.78$), as well as with biodegradable waste ($r = 0.75$). These findings emphasize that larger industrial zones not only increase overall solid waste generation but also generate substantial amounts of biodegradable waste and sludge from internal operations. The strong relationship between in-house sludge and hazardous waste ($r = 0.90$) further supports this observation, indicating that waste streams generated within industries often comprise both hazardous and non-hazardous components, most probably due to the complex nature of production processes and treatment processes.

Solid waste also indicated a strong correlation with biodegradable waste ($r = 0.91$), showing the substantial portion of organic matter within the overall solid waste category. Additionally, solid waste reported considerable correlations with hazardous waste ($r = 0.75$) and in-house treatment plant sludge ($r = 0.72$), emphasizing the interrelated nature of waste types produced in industrial activities. This type of interconnected and overlapping nature of different waste streams is produced through complex industrial processes.

Table 01: The Spearman correlation analysis for the industrial waste categories

	No. of industries	**Solid waste**	**Fabric waste**	**Biodegradable waste**	**Treatment plant sludge**	**In-house treatment plant sludge**	**Hazardous waste**	**Other waste**
No. of industries	1.00	0.73	0.58	0.75	0.47	0.78	0.87	0.66
Solid waste	0.73	1.00	0.37	0.91	0.63	0.72	0.75	0.42
Fabric waste	0.58	0.37	1.00	0.39	0.17	0.40	0.64	0.79
Biodegra dable waste	0.75	0.91	0.39	1.00	0.55	0.63	0.77	0.56
Treatment plant sludge	0.47	0.63	0.17	0.55	1.00	0.79	0.65	0.07
In-house plant sludge	0.78	0.72	0.40	0.63	0.63	1.00	0.90	0.25
Hazardo us waste	0.87	0.75	0.64	0.77	0.77	0.90	1.00	0.53
Other waste	0.66	0.42	0.79	0.56	0.56	0.25	0.53	1.00

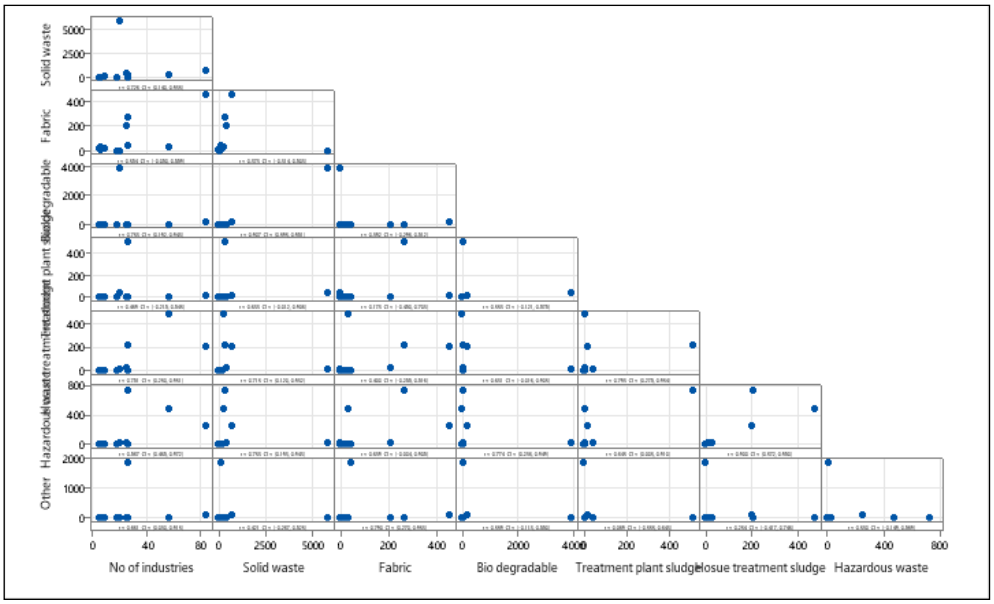

Figure 01: The Spearman correlation matrix at a 95% Confidence level. This matrix illustrates the strength and direction of monotonic relationships between variables, with correlation coefficients ranging from 0 to +1 (strong positive correlation).

An interesting pattern between fabric waste and other waste (r = 0.79), and fabric waste and hazardous waste (r = 0.64), suggesting that fabric waste-producing industries are more likely to generate diverse types of residual waste, including potentially hazardous materials such as dye and chemical residuals. On the other hand, relatively weak correlations were reported between treatment plant sludge and fabric waste (r = 0.17) and treatment plant sludge and other waste (r = 0.07), indicating that the sludge produced in treatment plants may follow distinct waste management pathways.

So, this study indicated that industrial waste is not produced in isolated categories, but rather through interconnected waste streams, with strong linkages between the number of industries operating within a zone and the quantities of various waste types generated.

CONCLUSIONS/RECOMMENDATIONS

This study reveals that most waste categories show moderate to strong positive correlations with the number of industries in industrial zones, indicating that as the number of industries increases, waste generation also rises, and the patterns become more complex. These findings underscore the need for integrated waste management strategies that address the combined and interacting effects of multiple waste types.

Therefore, prioritizing hazardous waste and sludge management in industrial regions will be essential to minimizing environmental impacts and safeguarding public health.

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REFERENCES

Abeysooriya, A. P. S. W., Bandara, E. G. K. Y. C., Sanjaya, H. L. K., Jye, M. W., Patabandi, P. P. S. K., Mejjad, N., … & Wijesinghe, R. D. N. (2024). Assessment of heavy metal pollution and human health risks associated with *Etroplus suratensis* (Green Chromide) in Koggala Lagoon, Sri Lanka.

Chaaban, M. A. (2001). Hazardous waste source reduction in materials and processing technologies. *Journal of Materials Processing Technology, 119*(1–3), 336–343. https://doi.org/10.1016/S0924-0136(01)00959-3

Fatimah, Y. A., Govindan, K., Murniningsih, R., & Setiawan, A. (2020). Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia. *Journal of Cleaner Production, 269*, 122263. https://doi.org/10.1016/j.jclepro.2020.122263

Shiwanthi, S., Lokupitiya, E., & Peiris, S. (2018). Evaluation of the environmental and economic performances of three selected textile factories in Biyagama Export Processing Zone, Sri Lanka. *Environmental Development, 27*, 70–82. https://doi.org/10.1016/j.envdev.2018.08.003