



## Dental Waste Management Strategies in Dental Clinics: Exploring the Relationship between Cost Efficiency, Environmental Impact, and Regulatory Compliance

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### Abstract

Dental waste management has emerged as a critical global issue due to its significant environmental, economic, and regulatory implications. Dental clinics generate a variety of wastes—from hazardous materials such as mercury and lead in amalgams to biomedical contaminants and chemical disinfectants—that require specialized handling to prevent health risks and environmental degradation. Existing studies indicate that although most healthcare waste is non-hazardous, the mismanagement of the hazardous fraction can lead to severe environmental and public health consequences. Despite established regulatory frameworks, gaps remain in integrating cost efficiency with sustainable environmental practices, burdening dental practices with unsustainable operational costs. This study aims to explore the interplay between cost efficiency, environmental impact, and regulatory compliance in dental waste management. It seeks to assess current waste management practices in dental clinics, evaluate their economic and environmental implications, and develop sustainable, compliant strategies to improve waste disposal processes in dental settings. A descriptive-correlational research design was employed, using a self-developed three-part questionnaire administered to 78 respondents from private dental clinics in New Cairo, Cairo. The instrument, validated through expert review and pilot testing (Cronbach's alpha = 0.98), captured perceptions on cost efficiency, environmental impact, and regulatory compliance. Data were analyzed using weighted mean scores and Pearson correlation analysis to determine the relationships among the three key dimensions.

The findings revealed positive perceptions across all dimensions, with average weighted means of 3.19 for cost efficiency, 3.23 for environmental impact, and 3.17 for regulatory compliance. Notably, significant correlations were observed between regulatory compliance and cost efficiency ( $r = 0.921$ ,  $p = 0.000$ ) and between regulatory compliance and environmental impact ( $r = 0.940$ ,  $p = 0.000$ ), indicating that improvements in cost-effective waste management practices are closely linked with better regulatory adherence and enhanced environmental performance. These results underscore the need for an integrated approach to dental waste management. By adopting sustainable and compliant strategies—such as standardized waste segregation, cost-effective hazardous waste disposal, and continuous staff training—dental clinics can achieve long-term financial savings, reduce environmental risks, and meet regulatory standards. The study advocates for a holistic waste management framework based on the Triple Bottom Line approach to ensure that economic efficiency, environmental stewardship, and regulatory compliance are addressed simultaneously.

**Keywords:** Dental waste management, cost efficiency, environmental impact, regulatory compliance, sustainable practices, Triple Bottom Line

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### Introduction

Dental waste management has emerged as a critical global issue, given its far-reaching environmental, economic, and regulatory implications. Dental clinics produce a wide range of waste—from mercury and lead in amalgams to biomedical contaminants and chemical disinfectants—that require specialized handling to prevent serious risks to human health and environmental degradation. Numerous studies underscore the urgency of addressing these challenges.

For instance, Solomon *et al.* (2021) report that although 75–90% of healthcare waste is non-hazardous, the remaining fraction can be extremely dangerous if mismanaged, while Golandaj *et al.* (2021)<sup>[14]</sup> highlight how improper segregation heightens risks for healthcare workers and patients. Further, research by Duane *et al.* (2019)<sup>[7]</sup> and Subramanian *et al.* (2021) reveals that current waste management practices often fall short in mitigating environmental damage, particularly concerning mercury emissions.

Despite extensive focus on regulatory compliance in dental waste management, a notable gap persists in integrating cost efficiency with sustainable environmental practices. While existing strategies ensure adherence to health and safety regulations—as exemplified by the Egyptian Environmental Protection Law and WHO’s waste classification—they frequently overlook the economic feasibility and long-term ecological impact of disposal methods. This oversight not only jeopardizes environmental safety but also burdens dental practices with unsustainable operational costs.

In response to these shortcomings, this study was conducted to bridge this gap by exploring the interplay between cost efficiency, environmental impact, and regulatory compliance in dental waste management. By systematically assessing the economic viability and ecological consequences of various waste management practices, this research seeks to offer actionable insights for dental clinics and policymakers. Ultimately, the study aspires to develop a scalable, optimized model for dental waste disposal that enhances sustainability, ensures regulatory adherence, and improves financial viability across diverse healthcare settings.

## Methods

This study utilized a descriptive-correlational research design to describe existing dental waste management practices and explore relationships among cost efficiency, environmental impact, and regulatory compliance. A descriptive-correlational design is employed when the researcher aims to describe the relationship between variables without inferring a causal connection. Primary data were collected via self-administered surveys from dental practitioners, clinic administrators, and waste management personnel in private dental clinics in New Cairo, Cairo, Egypt. The population comprised ninety-six (96) professionals; a sample of seventy-eight (78) respondents was determined using the Raosoft calculator (95% confidence level, 5% margin of error) and selected through simple random sampling.

The researcher utilized a three-part, researcher-developed questionnaire measured. The first part of the questionnaire obtained the demographics of the respondents (role in clinic, years of experience, years of waste management practice). The second part determined the Perceptions of dental waste management across cost efficiency, environmental impact, and regulatory compliance, using closed-ended items on a four-point Likert scale. Finally, the third part of the questionnaire evaluated the overall satisfaction with current waste management strategies.

Face validity was established by a three-member expert panel (research, statistics, hospital administration), and construct validity was confirmed through continuous adviser consultation. Pilot testing with fifteen (15) professionals

yielded high reliability Cronbach’s  $\alpha = 0.98$ .

Included in the questionnaire is an informed consent that guaranteed the respondents’ confidentiality and stated that if they continued, they would be agreeing to the study’s purpose. The questionnaire was developed using google forms. The respondents were invited to take part in this study, and that their participation was entirely voluntary.

For the statistical treatment of this study, the following were utilized by the researcher. Percentages and frequencies for demographic variables; weighted means for perceptions and satisfaction levels. Pearson correlation to examine relationships among cost efficiency, environmental impact, and regulatory compliance.

## Results and Discussions

This chapter presents the analysis and interpretation of the data collected, which facilitated a clearer understanding of the study’s findings.

### 1. Respondents’ Profile

**Table 1:** The Profile of the Respondents

	Profile	Frequency	Percentage
Role in Clinic	Clinic administrator	16	20.51
	Dental practitioner	31	39.74
	Waste management personnel	18	23.08
	Dental assistant	13	16.67
Years of practice	Under 5	17	21.79
	5-10	27	34.62
	11-20	27	34.62
	Over 20	7	8.97
Total Number of Respondents = 78			

Table 1 presents the profile of the respondents. It yielded a total of seventy-eight (78) respondents from private dental clinics in New Cairo, Cairo, Egypt

As for Role in clinic, table 1 shows that most of the respondents in terms of their role in clinic were Dental practitioners (n=31) with a percentage of 39.74% followed by waste management personnel (n=18) which yielded a 23.08% and then clinic administrators (n=16) with a percentage of 20.51% and the least were dental assistant (n=13) with a percentage of 16.67%. This distribution indicates that the data collected represents a well-rounded perspective from various roles within dental clinics and provides valuable insights into both strategic and operational dimensions of practices.

In regards to years of experience, looking at the results, a significant portion of respondents have 5–20 years of experience (34.62% each for 5–10 and 11–20 years), indicating a moderately experienced cohort. This distribution provides a balanced perspective on the prevailing practices in dental waste management and also this signifies a relatively mature and seasoned group of professionals capable of making informed evaluations of current waste management practices. The presence of highly experienced respondents (>21 years at 8.97%) further enriches the reliability of the findings.

## 2. Current Dental Waste Management Practices

**Table 2:** Current Waste Management Practices

	Indicator	Frequency	Percentage
Formal, written waste management protocol	Yes	54	69.23
	No	9	11.54
	In development	15	19.23
Type of waste generated	General waste	72	92.31
	Hazardous waste	6	7.69
*Waste segregation	Color-coded bins	55	70.51
	Clearly labeled containers	46	58.97
	No formal segregation system	4	5.12
*Disposal of hazardous dental waste	In-house treatment before disposal	29	37.18
	Collection by a licensed waste management company	47	60.26
	Disposal mixed with general waste	6	7.69
Frequency of dental waste collection	Daily	12	15.38
	Weekly	42	53.85
	Biweekly	14	17.95
	Monthly	10	12.82
Total Number of Respondents = 78			
*Multiple Responses			

Table 2 presents a comprehensive overview of the current waste management practices observed in the surveyed dental clinics. The table is organized into several sections, each detailing a different aspect of waste management. These include the presence of formal waste management protocols, the types of waste generated, waste segregation practices, methods of disposing of hazardous dental waste, and the frequency of waste collection. Each section lists specific indicators along with the frequency and corresponding percentage of respondents reporting each practice.

For formal written waste management protocol, the data revealed that 69.23% of clinics had a formal, written waste management protocol, while 19.23% were still in the process of developing one. However, 11.54% of respondents indicated an absence of such protocols, which is concerning given the potential legal and health implications of unstandardized waste disposal.

As for type of waste generated, the data show that a substantial majority of clinics (92.31%, or 72 respondents) produce primarily general waste. In contrast, hazardous waste—though only 7.69% (6 respondents) of the total—is significant due to the high risk associated with its improper disposal. This disparity highlights the need for specialized

handling of hazardous materials, even if they constitute a smaller proportion of the overall waste.

On waste segregation practices, 70.51% of clinics reported the use of color-coded bins, and 58.97% utilized clearly labeled containers. Yet, a small fraction (5.12%) lacked a formal segregation system. This inconsistency could lead to contamination risks, inefficient waste handling, and higher disposal costs due to improper categorization.

In regards to disposal of hazardous dental waste, a majority (60.26%) relied on licensed waste management companies, which aligns with best practices. However, the finding that 7.69% still dispose of hazardous waste mixed with general waste is alarming and indicative of serious compliance lapses. These practices undermine environmental protection goals and potentially violate health regulations.

For the frequency of dental waste collection, the frequency of waste collection was predominantly weekly (53.85%), followed by biweekly (17.95%) and monthly (12.82%). Only 15.38% conducted daily waste collection. While weekly collection is common, less frequent collection might pose sanitation risks, especially in clinics generating a high volume of waste.

## 3. Economic and Environmental Impacts of Dental Waste Management Practices

**Table 3:** Economic Impacts of Dental Waste Management Practices

	Indicator	Weighted Mean	Verbal Interpretation	Rank
<b>Cost efficiency</b>				
1.	The financial resources allocated for dental waste management in this facility are sufficient.	3.32	Positive	3
2.	The facility has access to cost-effective and reliable waste management services.	3.17	Positive	4
3.	The cost of hazardous waste disposal (e.g., amalgam, sharps) is reasonable and sustainable.	3.00	Positive	7
4.	Proper waste segregation reduces unnecessary expenses associated with waste disposal.	3.35	Positive	2
5.	Sterilization and disinfection methods utilized in this facility optimize cost and waste reduction.	3.08	Positive	5
6.	The facility has implemented cost-saving strategies (e.g., bulk purchasing, in-house treatment).	3.05	Positive	6
7.	Investment in proper waste management practices results in long-term cost savings.	3.40	Positive	1
Overall Weighted Mean		3.19	Positive	

Presented in Table 3 the respondents' perception on the economic impact of dental waste management in terms of cost efficiency was positive with an average mean of 3.19.

This means that dental clinics generally perceive their waste management practices as economically beneficial—especially in terms of long-term savings and effective

segregation. However, the financial challenges related to hazardous waste disposal persist as a significant concern. Addressing this disparity may require innovations in hazardous waste treatment technologies, better regulatory incentives, or improved protocols that specifically target the reduction of hazardous waste handling costs.

Specifically, their perception on the cost efficiency impact was positive in the following indicators: indicator #7 “Investment in proper waste management practices results in long-term cost savings” with a mean of 3.40 (Rank 1), then followed by indicator #4 “Proper waste segregation reduces unnecessary expenses associated with waste disposal” with a mean of 3.35 (Rank 2), and the least is indicator #3 “The cost of hazardous waste disposal (e.g., amalgam, sharps) is reasonable and sustainable” with a weighted mean of 3.17 (Rank 7).

The results imply that respondents strongly agree that investing in proper waste management practices leads to long-term cost savings. This suggests that dental clinics recognize the value of upfront expenditures on advanced waste management systems—such as specialized treatment units or infrastructure upgrades—as a strategic means to mitigate recurrent expenses. The anticipated savings may include reduced disposal fees, fewer fines from non-compliance, and lower remediation costs. This interpretation is supported by literature from Di Foggia and Beccarello (2020) [6] and Lee *et al.* (2022) [20], which argue that initial investments in sustainable waste management often pay off over time by enhancing operational efficiency and reducing overall costs. Moreover, the theoretical framework discussed by Nikmah (2024) [30] within the study underlines that integrating cost efficiency with environmental and regulatory

aspects can lead to long-term financial and operational benefits.

A high weighted mean for proper waste segregation indicates that respondents’ value systematic categorization of waste, as it directly minimizes unnecessary expenses. Efficient segregation ensures that non-hazardous waste is not erroneously treated as hazardous waste, which typically incurs higher disposal fees. This finding aligns with studies by Alshammari *et al.* (2021) [3] and the observations of Lakbala (2020) [19], who both highlight that implementing standardized protocols—such as color-coded bins and clearly labeled containers—can reduce disposal costs and improve compliance with environmental standards. In this context, effective waste segregation is seen not merely as an operational requirement but as a critical cost-saving mechanism.

Despite overall positive perceptions, the lowest score was assigned to the cost of hazardous waste disposal. This indicates that respondents view the financial burden of managing hazardous materials (e.g., amalgam, sharps) as relatively high compared to other aspects of waste management. The specialized handling requirements, stringent regulatory mandates, and limited cost-effective disposal options for hazardous waste are likely factors driving this perception. This is consistent with findings by Myszograj (2023) [27] and Duong (2019) [9], who have documented the economic challenges posed by hazardous waste disposal in dental settings. The relatively lower mean suggests that while dental clinics may achieve cost efficiency in other areas, the expense associated with hazardous waste remains a critical issue that warrants further attention.

**Table 4:** Environmental Impacts of Dental Waste Management Practices

	Indicator	Weighted Mean	Verbal Interpretation	Rank
<b>Environmental impact</b>				
1.	The facility adheres to proper waste segregation protocols to minimize environmental contamination.	3.40	Positive	1
2.	I am aware of the environmental risks associated with improper dental waste disposal.	3.38	Positive	2
3.	Mercury-containing waste, such as dental amalgam, is disposed of in accordance with environmentally safe practices.	3.03	Positive	6.5
4.	Recyclable materials (e.g., plastics, paper) generated from dental procedures are appropriately processed	3.24	Positive	5
5.	The use of plastic and other non-biodegradable materials is minimized in daily operations	3.03	Positive	6.5
6.	Our waste management practices significantly reduce the environmental impact (e.g., through recycling or proper treatment).	3.26	Positive	4
7.	The transition to digital records and imaging has contributed to a reduction in paper and chemical waste.	3.27	Positive	3
Overall Weighted Mean		3.23	Positive	

As presented on Table 4 the respondents’ perception on the environmental impact of dental waste management was positive with an average weighted mean of 3.23. These findings suggest that dental clinics are effectively implementing key environmental measures, particularly through rigorous waste segregation practices, which are critical in preventing cross-contamination and reducing overall environmental hazards. The high score for adherence to waste segregation protocols indicates a strong commitment to minimizing environmental contamination at the source, a strategy that aligns with the recommendations from Lakbala (2020) [19] and the standard operating procedures advocated by the NCDC (2021).

Specifically, the respondents’ perception on environmental impact was positive in indicator #1 “The facility adheres to proper waste segregation protocols to minimize

environmental contamination” with a weighted mean of 3.40 (Rank 1), then followed by indicator # 2 “I am aware of the environmental risks associated with improper dental waste disposal” with a weighted mean of 3.38 (Rank 2 ), and the least are indicator #3 “Mercury-containing waste, such as dental amalgam, is disposed of in accordance with environmentally safe practices” and indicator #5 “The use of plastic and other non-biodegradable materials is minimized in daily operations” with both having a weighted mean of 3.03 (Rank 6.5).

Moreover, the respondents’ high level of awareness regarding the environmental risks of improper waste disposal reinforces the importance of continuous education and training in sustainable practices. Such awareness is crucial for fostering a culture of environmental responsibility among dental practitioners, as noted by Mariam *et al.* (2022).

However, the relatively lower ratings for the disposal of mercury-containing waste and the minimization of non-biodegradable materials highlight persistent challenges. These areas likely reflect the complexities and higher costs

associated with managing hazardous materials safely—a concern also raised by Duane *et al.* (2019)<sup>[8]</sup> and Mitsika (2024)<sup>[26]</sup>.

#### 4. Regulatory Compliance for Dental Waste Disposal

**Table 5:** Regulatory Compliance for Dental Waste Disposal

Indicator	Weighted Mean	Verbal Interpretation	Rank
<b>Cost efficiency</b>			
1. The facility adheres to proper waste segregation protocols to minimize environmental contamination.	3.44	Positive	1
2. I am aware of the environmental risks associated with improper dental waste disposal.	3.18	Positive	3
3. Mercury-containing waste, such as dental amalgam, is disposed of in accordance with environmentally safe practices.	3.12	Positive	5
4. Recyclable materials (e.g., plastics, paper) generated from dental procedures are appropriately processed	3.03	Positive	7
5. The use of plastic and other non-biodegradable materials is minimized in daily operations	3.22	Positive	2
6. Our waste management practices significantly reduce the environmental impact (e.g., through recycling or proper treatment).	3.17	Positive	4
7. The transition to digital records and imaging has contributed to a reduction in paper and chemical waste.	3.06	Positive	6
Overall Weighted Mean	3.17	Positive	

As presented in Table 5 the respondents’ perception on the regulatory compliance of dental waste disposal was positive with an average mean of 3.17. The study implies that, overall, dental clinics are perceived to be largely compliant with regulatory guidelines for waste disposal.

Specifically, their perception on the regulatory compliance was positive in the following indicators: indicator #1 “The facility adheres to proper waste segregation protocols to minimize environmental contamination” with a mean of 3.44 (Rank 1), followed by indicator #5 “The use of plastic and other non-biodegradable materials is minimized in daily operations” with a mean of 3.22 (Rank 2). The least is indicator #4 “Recyclable materials (e.g., plastics, paper) generated from dental procedures are appropriately processed” with a weighted mean of 3.03 (Rank 7).

The highest score for adherence to proper waste segregation protocols underscores the central role of segregation in ensuring compliance and reducing environmental contamination—a practice that aligns with the recommendations presented by Lakbala (2020)<sup>[19]</sup> and further emphasized by the collaborative work of the NCDC (2021). The relatively strong score for minimizing the use of non-biodegradable materials indicates that efforts to reduce the environmental footprint extend into daily operational practices, which is critical for long-term sustainability as noted by various studies in this field.

However, the lower score for the processing of recyclable materials points to a potential area of improvement. This indicator, scoring the lowest among the compliance measures, suggests that while basic compliance protocols are well-implemented, there remains a gap in fully optimizing recycling processes. Literature from studies by Jagun *et al.* (2022)<sup>[17]</sup> and Lopez *et al.* (2021)<sup>[21]</sup> supports the notion that inconsistent processing of recyclables can undermine the overall effectiveness of waste management systems, even in settings that perform well in other regulatory aspects.

Furthermore, addressing this gap in recycling efficiency may require a multifaceted approach. Dental clinics could benefit from investing in advanced recycling technologies and digital tracking tools to monitor waste streams more accurately. Additionally, targeted training programs and enhanced awareness initiatives for staff could improve the handling and

processing of recyclable materials. By integrating technological upgrades with strategic policy incentives, dental clinics can further elevate their regulatory compliance and contribute more robustly to environmental sustainability.

#### 5. Relationship between Cost Efficiency, Environmental Impact and Regulatory Compliance in Dental Waste Management

**Table 6:** Relationship between Cost Efficiency, Environmental Impact and Regulatory Compliance in Dental Waste Management

	Regulatory compliance
Cost efficiency	r=0.921** High correlation p=0.000
Environmental impact	r=0.940** High correlation p=0.000
**Significant @ 0.01	

Presented in Table 6 are the statistical relationships among cost efficiency, environmental impact, and regulatory compliance in dental waste management. The table shows that there is a very strong positive correlation between regulatory compliance and cost efficiency, with a correlation coefficient of  $r = 0.921$ , which is statistically significant ( $p = 0.000$ , significant at the 0.01 level) and a higher positive correlation between regulatory compliance and environmental impact ( $r = 0.940$ ,  $p = 0.000$ , significant at the 0.01 level). This means that the better the cost efficiency and environmental impact, the higher the regulatory compliance with dental waste management.

Likewise, the result implies that as dental clinics enhance their cost-effective practices in managing waste, they are also more likely to adhere strictly to regulatory standards. This indicates that improved regulatory compliance is associated with better environmental outcomes, such as more effective waste segregation and environmentally safe disposal methods. These strong correlations imply that a holistic approach to dental waste management can yield multiple benefits. When clinics invest in measures to comply with regulations—such as proper waste segregation protocols,

safe disposal methods, and the minimization of non-biodegradable materials—they not only reduce potential legal and environmental risks but also achieve cost savings over time. Literature in the field supports this interconnectedness; for example, Di Foggia and Beccarello (2020) [6] have noted that rigorous compliance with environmental standards often leads to reduced operational costs, while research by Yeoh *et al.* (2024) [36] emphasizes the dual benefits of environmental improvements and economic savings.

Further reinforcing this perspective, Slutzman *et al.* (2023) [34] demonstrated that integrating digital waste tracking and monitoring systems significantly enhances operational efficiency and regulatory compliance. Guo (2021) [35] also highlighted that adopting cost-effective waste management solutions optimizes resource use and reduces waste generation, thereby improving environmental performance. Moreover, Alavi *et al.* (2024) [4] advocate for an integrated approach that simultaneously addresses cost efficiency, environmental impact, and regulatory compliance, emphasizing that such a holistic strategy is critical for the long-term sustainability of waste management systems.

## 6. Sustainable and compliant strategies to improve dental waste management practices

Based on the collective findings, several sustainable and compliant strategies can be developed to improve dental waste management practices in dental clinics.

First, it is critical to establish and maintain formal, written waste management protocols across all clinics. These protocols should be supported by regular training programs and refresher courses for all staff—including dental practitioners, administrators, and waste management personnel—to ensure a comprehensive understanding of proper waste segregation, handling, and disposal procedures. Enhanced training can address knowledge gaps in hazardous waste classification and reinforce the practice of not mixing hazardous waste with general waste, an approach that aligns with recommendations from the Lakbala (2020) [19] and NCDC (2021).

Standardization of waste segregation must be reinforced by mandating the use of color-coded bins and clearly labeled containers. Although most respondents reported using such systems, the existence of clinics without formal segregation practices highlights the need for consistent implementation. Periodic internal audits should be conducted to verify that waste is correctly segregated at the point of generation, thereby minimizing contamination risks and reducing disposal costs.

Sustainable disposal practices for hazardous waste should be prioritized by partnering with licensed waste management companies. The strong positive correlations among regulatory compliance, cost efficiency, and environmental impact suggest that outsourcing hazardous waste disposal can yield significant economic savings while enhancing environmental outcomes. Where feasible, in-house treatment strategies may be explored, provided that strict adherence to safety and regulatory standards is maintained, as supported by studies from Di Foggia and Beccarello (2020) [6] and Lee *et al.* (2022) [20].

Integrating cost-saving strategies—such as bulk purchasing of waste management supplies and optimizing in-house waste processing—can also contribute to long-term financial savings. These measures, when combined with

environmental initiatives like reducing the use of non-biodegradable materials and transitioning to digital records, create a more sustainable operation that minimizes both operational costs and environmental impact. The adoption of digital tracking systems, as demonstrated by Slutzman *et al.* (2023) [34] and further highlighted by Guo (2021) [35], can optimize resource use and enhance waste monitoring.

Given the strong interrelationships among cost efficiency, environmental impact, and regulatory compliance, an integrated, comprehensive approach is essential. Developing an overarching waste management framework based on the Triple Bottom Line approach (Nikmah, 2024) [30] will ensure that economic efficiency, environmental impact, and regulatory compliance are addressed simultaneously.

## Conclusion and Recommendation

The findings of this study indicate that private dental clinics in New Cairo generally hold positive views toward their waste management practices, as evidenced by weighted means of 3.19 for cost efficiency, 3.23 for environmental impact, and 3.17 for regulatory compliance. Most clinics have adopted formal protocols and color-coded segregation systems, demonstrating a commitment to safe and sustainable operations. However, challenges persist in the handling and disposal costs of hazardous waste, which remain a significant concern despite regulatory frameworks. The strong, statistically significant correlations ( $r = 0.921$  and  $r = 0.940$ ;  $p < 0.001$ ) between regulatory compliance and both economic and environmental performance underscore the critical role of adherence to guidelines in driving cost savings and ecological benefits.

To build on these strengths and address existing gaps, clinics should standardize a uniform, color-coded segregation protocol across all facilities and ensure clear labeling and instructional signage for staff. Partnerships with licensed disposal companies can be leveraged to secure volume-based pricing, while investments in on-site amalgam separators and eco-sterilization units will help reduce long-term hazardous waste disposal costs. Regular, hands-on training workshops and awareness campaigns can further reinforce best practices, and collaboration with health authorities to introduce incentives—such as tax rebates or certification benefits—could motivate exemplary performance. Finally, establishing a biannual audit and feedback mechanism will support continuous monitoring, evaluation, and improvement of waste management processes, fostering a culture of sustainability and compliance.

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