

Impact of construction and demolition waste management on environmental sustainability in Lunahuana: A correlational study



Mirna Yactayo-Ormeño*, Miriam Ñañez-Silva, Nestor Cuba-Carbajal

Facultad de Ciencias Empresariales, Universidad Nacional de Cañete, Lima, Peru

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ABSTRACT

This research investigates the pivotal relationship between construction and demolition waste management and its profound implications for environmental sustainability within the Lunahuana region. Employing a methodological framework rooted in basic research, the study adopts a quantitative approach with a non-experimental design and a correlational perspective. The research population encompasses 4,393 residents of Lunahuana, from which a representative sample of 353 residents was randomly selected using probabilistic sampling techniques. The research methodology incorporates survey-based data collection, deploying two meticulously designed questionnaires. The first questionnaire focuses on assessing variables associated with construction and demolition waste management, while the second explores facets of tourism environmental sustainability. Statistical analysis of the collected data reveals a statistically significant relationship (significance value of 0.00, <0.05 at a 95% confidence level) between construction and demolition waste management practices and the environmental sustainability of tourism in Lunahuana. In conclusion, the effective management of construction and demolition waste emerges as a pivotal factor in fostering tourism environmental sustainability in Lunahuana. Proper waste management plays a crucial role in safeguarding diverse environments, including roads, riverbanks, sidewalks, residential facades, and tourist centers. Such practices are vital in preserving the scenic beauty and preventing environmental degradation for both present and future generations.

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1. Introduction

Construction and demolition waste (CDW) comprises materials arising from construction and demolition endeavors. A considerable portion of this waste finds its way to landfills, where improper disposal practices give rise to multifarious environmental predicaments across diverse domains, including soil, air, water, flora, fauna, and the overall landscape. Maciel et al. (2016) posit that waste generation is an inherent consequence of all production processes, with the construction sector ranking among the most prolific contributors in this regard. Correspondingly, del Pozo et al. (2011) affirm that CDWs precipitate myriad complications, encompassing soil and water contamination due to

unregulated discharges, landscape deterioration, and disposal devoid of recycling or repurposing efforts.

The World Tourism Organization (WTO), during the World Conference on the Charter for Sustainable Tourism in 1993, stipulated in principle number two that governments, authorities, and tourism professionals must adhere to the following tenet: "Tourism should conduce to sustainable development, harmoniously integrating within the natural, cultural, and human milieu, while preserving the delicate equilibriums characterizing numerous tourist destinations, particularly diminutive islands and ecologically vulnerable zones." In this context, tourism necessitates a forward-looking trajectory that aligns acceptably with its impact on natural resources, biodiversity, and the capacity to assimilate the ensuing effects and waste output.

Within Europe, Directive (EU) 2018/851 delineates fundamental concepts and definitions relevant to waste management, underpinning the pursuit of two recycling and recovery targets. Member States are mandated to incorporate waste management strategies and preventative programs,

* Corresponding Author.

Email Address: 1574237336@undc.edu.pe (M. Yactayo-Ormeño)

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Corresponding author's ORCID profile:

<https://orcid.org/0000-0001-8808-930X>

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thus orchestrating a reversal of the prevailing landscape and a transition to a more sustainable system. In nations such as Denmark, Germany, the Netherlands, and the United Kingdom, which constitute its constituents, the imperative for sustainable waste management and the utilization of natural resources as construction material feedstock has been duly recognized, given that municipal waste constitutes approximately 7% to 10% of the overall waste corpus. Targets have been instituted to assess CDW for its potential for reuse, recovery, and recycling, commencing in the year 2020.

In Latin American nations, including Colombia, Mexico, and Argentina, regulatory frameworks governing the management of CDW are extant; nonetheless, a substantial proportion of stakeholders fail to adhere to these provisions, thereby imperiling the environment and fostering the proliferation of illicit dumping sites. As articulated by [Yeheyis et al. \(2013\)](#), residual construction debris (RCD) generated by the Canadian construction sector has exacerbated the dearth of landfill capacities, thereby engendering multifaceted environmental, economic, and societal ramifications. Consequently, the sustainable management of RCDs has become increasingly imperative to safeguard public health and the integrity of natural ecosystems. In the case of Peru, as delineated by [Oefa \(2016\)](#), three salient challenges regarding CDW generation persist, namely: the absence of dedicated disposal facilities for CDW arising from construction and demolition activities, the prevalence of informal dumpsites, and the lack of segregation and waste minimization protocols. Furthermore, CDWs constitute the second most significant category, accounting for 3.58% of the nation's total solid waste generation. This predicament is exacerbated by the prioritization of municipal solid waste management by the state, which is coupled with the absence of an efficacious framework for CDW management, thereby compromising the quality of the urban environment.

Within the district of Lunahuana, located in the province of Cañete, Peru, a discernible pattern has emerged: the confluence of population expansion and urban development has engendered an upsurge in construction and renovation activities, accompanied by a commensurate escalation in unregulated waste generation. This alarming phenomenon transpires devoid of any municipal organization or community-led management initiatives, culminating in the indiscriminate accumulation of waste along the banks of the Cañete River, in proximity to residential dwellings, and alongside thoroughfares. These developments evoke substantial concern, particularly owing to the district's popularity among national and international tourists, who frequent the area for recreational purposes, thereby availing themselves of various activities such as equestrian pursuits, all-terrain vehicle excursions, canoeing, and communion with the natural surroundings, all while savoring the scenic splendor. Consequently, it is against this

backdrop that the impetus for this research endeavor emerged, seeking to elucidate the nexus between construction and demolition waste management and the attainment of environmental sustainability within the context of tourism.

2. Theoretical bases

2.1. CDW

Solid waste management, denoted as CDW management, encompasses a spectrum of intricate technical-administrative undertakings. These encompass the formulation, orchestration, collaboration, design, execution, and assessment of policies, strategies, plans, and action programs designed to effectuate the judicious handling of solid waste. This purview extends to both municipal and non-municipal contexts, operating at national, regional, and local strata ([Guerrero et al., 2013](#)).

The United Nations Summit, as articulated in Principle 15 of the Rio Declaration on Environment and Development (1992), underscores the vital imperative of widely applying the precautionary approach to environmental protection. This approach mandates the judicious adoption of cost-effective measures to preclude environmental degradation, even in the absence of absolute scientific certainty, particularly in situations where serious or irreversible damage looms.

Legal frameworks, exemplified by Supreme Decree No. 019-2016-Housing in Peru, serve as pivotal enablers of solid waste management. This decree empowers local governments to establish collection centers and temporary storage facilities for solid waste from minor construction works, ensuring adherence to hygiene and safety standards. It also encourages strategies facilitating access to Solid Waste Service Providers Companies (EPS-RS) for the final disposal of waste, with an emphasis on reuse to minimize the volume destined for ultimate disposal.

Solid waste generation denotes the juncture when waste materializes due to human activities, spanning daily routines, commercial activities, public sanitation services, healthcare, construction, and related pursuits. Law No. 28611: General Law of the Environment in 2005 in Peru mandates the joint responsibility of local governments and waste generators to manage and oversee solid waste from inception to proper final disposal.

The facet of solid waste collection signifies the process of removing and transporting waste utilizing suitable means of conveyance, followed by subsequent management in a sanitary, secure, and ecologically sound manner. Legislative Decree No. 1278 in 2016 in Peru enshrines the state's guarantee of continuous, regular, permanent, and mandatory provision of public cleaning services, encompassing collection, transport, and final disposal of solid waste within specific jurisdictions, including debris and dismantling of minor construction works, as well as sweeping and cleaning of public areas.

Solid waste treatment pertains to processes, methods, or techniques aimed at altering the physical, chemical, or biological attributes of solid waste, thus diminishing or eliminating its potential for adverse health and environmental impacts. It additionally facilitates waste reuse, expediting its ultimate disposal in an efficient, secure, and hygienic manner. Supreme Decree No. 012-2009-MINAM in Peru underscores the imperative of enhanced municipal-level management of solid waste by regional and local governments, coupled with initiatives promoting environmental education, awareness, and public and private investments in solid waste projects.

Ministerial Resolution No. 191-2016-MINAM: National Plan for the Integral Management of Solid Waste, particularly in specific objectives 05 and 07, advocates the fortification of solid waste reuse systems, with a pronounced focus on the municipal level, while concurrently promoting coordinated investments at the national-level integrated solid waste management.

Solid waste disposal, the ultimate phase, entails the permanent, sanitary, and ecologically safe disposition of solid waste. The provision of municipal management, in compliance with Peru's environmental agency (Oefa, 2016), is predominantly achieved through landfill methods. Supreme Decree No. 014-2011-MINAM: National Environmental Action Plan – PLANAA (2011-2021) stipulates ambitious goals, including the comprehensive management, treatment, reuse, and proper final disposal of 100% of municipal-level solid waste by 2021, accompanied by robust recycling endeavors and measures to enhance waste separation and collection.

Supreme Decree No. 014-2017-MINAM: Regulation of Legislative Decree No. 1278 further delineates the need for differentiated cells for the final disposal of hazardous and non-hazardous solid waste, including waste from construction and demolition activities, under municipal management. The generators of specialized municipal solid waste bear the onus of ensuring its proper management, with the choice of services either through a Solid Waste Operating Company (EO-RS) or the corresponding municipality.

2.2. Tourism environmental sustainability

Tourism sustainability represents a strategic approach to resource management, ensuring that these resources can fulfill social and economic needs while upholding cultural identity, ecological equilibrium, biodiversity, and life-sustaining systems. Within the framework of Law No. 29408: General Tourism Law, Article 3 elucidates a fundamental principle of tourism activity, emphasizing the imperative of tourism development that encompasses the recuperation, preservation, and harmonious integration of cultural, natural, and social heritage. This principle is underpinned by the responsible utilization of tourism resources, aiming

to enhance the quality of life for local populations while fostering their socio-cultural and environmental advancement.

The role of a tour operator, as defined in Supreme Decree No. 004-2016-MINCETUR, encompasses the conception, design, contracting, organization, and execution of tourism programs and services within national territory. These services are offered through wholesale and retail travel and tourism agencies, both domestically and internationally, with the possibility of direct provision to tourists. An initiative known as the Tour Operators Initiative (TOI), established in 2000, encourages tour operators to commit to sustainable development. Supported by prominent organizations including UNWTO, the United Nations Environment Program (UNEP), and UNESCO, TOI underscores the importance of sustainable tourism practices.

Biological diversity, often referred to as biodiversity, encapsulates the array of living organisms within specific habitats or geographical regions, along with the intricate ecological systems of which they form a part. Biological resources derived from biodiversity are essential to human survival, underpinning agriculture, animal husbandry, forestry, fishing, medicine, industry, and tourism. Legal provisions, such as those outlined in Law No. 26839: Law on the Conservation and Sustainable Use of Biological Diversity, underscore the significance of education, information exchange, human resource development, scientific research, and technology transfer in preserving biodiversity and facilitating sustainable economic development through its responsible utilization.

Environmental conservation, synonymous with the conservation of natural resources, pertains to measures that ensure the continuity of these resources while safeguarding ecological processes, conserving biodiversity, and promoting sustainable resource utilization. Law No. 28611: General Law of the Environment, Article 11, specifically emphasizes the sustainable use of natural resources, encompassing the protection and restoration of ecosystems, species, and their genetic heritage. It underscores the critical importance of safeguarding against actions that may threaten or risk the extinction of any flora or fauna variety, alongside the sustainable development of urban and rural areas, the preservation of peri-urban agricultural regions, and the environmentally sustainable provision of public services. Additionally, it advocates for the conservation of cultural traditions, knowledge, and lifestyles of traditional communities and Indigenous peoples.

Cultural identity embodies a sense of belonging to a social group sharing cultural attributes such as customs, values, and beliefs. It is historically defined through diverse elements reflecting the culture, including language, social relations, rituals, ceremonies, collective behaviors, and systems of values and beliefs. These elements are inherently intangible and communal, collectively shaped and upheld over time.

Article 29 of Law No. 28296: General Law on the Cultural Heritage of the Nation mandates municipalities to enact administrative measures for safeguarding, conserving, and disseminating assets constituting the Cultural Heritage of the Nation within their jurisdiction. Furthermore, municipalities are entrusted with crafting plans and programs aimed at the protection, preservation, and dissemination of these cultural assets.

3. Methodology

This study falls within the purview of fundamental research, as defined by Dien et al. (2004), which pertains to the systematic exploration of knowledge and truths enabling the description, explanation, generalization, and prediction of phenomena occurring in the natural world and societies. In particular, this research adopts a descriptive-correlational approach, aiming to assess the interrelationship between the study variable and dimensions encompassing the management of CDW. These dimensions encompass the management of RCD generation, collection, treatment, and disposition. The research design employed is non-experimental and cross-sectional, as it involves the collection of data at a specific point in time. To gather information, a survey technique was utilized, involving the administration of two distinct questionnaires. The first questionnaire centered on the variable of "Management of construction and demolition waste," while the second focused on the variable of "Tourism environmental sustainability."

4. Results

4.1. Descriptive analysis

The variable pertaining to the management of CDW exhibits a frequency of occurrence of 81.60% (n= 288), while the remaining 18.40% (n = 65) corresponds to a significantly lower occurrence. This distribution leads to the deduction that effective management of construction and demolition waste is lacking within the district of Lunahuana. Fig. 1 presents a visual representation of the responses

provided by the residents of Lunahuana regarding the management of CDW.

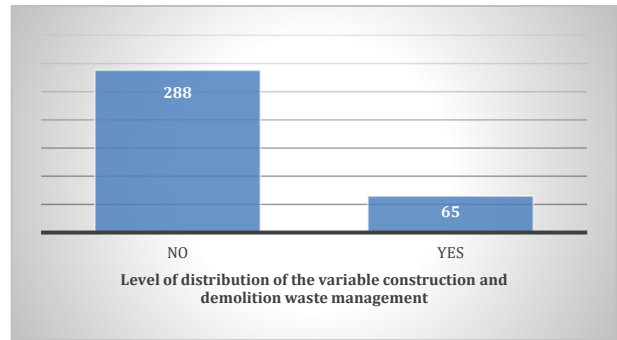


Fig. 1: Level of distribution of the variable construction and demolition waste management

The dimensions related to the management of CDW exhibit varying frequencies of occurrence. For the dimension concerning the generation of CDW management, 45% of respondents chose "no" (n=159), while 55% responded with "yes" (n=194). This suggests that approximately only half of the population engaged in commendable practices during the CDW generation. Regarding the management of CDW collection, a substantial 80.20% responded negatively (n=283), with only 19.80% affirming positively (n=70). This implies that the population does not engage in any form of CDW collection management, nor do they possess the requisite materials or equipment for proper storage.

In the context of CDW treatment management, a striking 82.40% of respondents opted for "no" (n=291), with a mere 17.60% selecting "yes" (n=62). This indicates that the population neither categorizes CDWs nor reuses them, and furthermore, they appear to lack awareness of any associated sanctions for these actions.

Lastly, concerning the management of CDW disposal, an overwhelming 92.90% indicated "no" (n=328), while only 7.1% responded with "yes" (n=25). This suggests that the district of Lunahuana lacks a suitable collection center for the proper disposal of construction and demolition waste. Fig. 2 visually illustrates the management dimensions of CDW generation, CDW collection, CDW treatment, and CDW disposition.

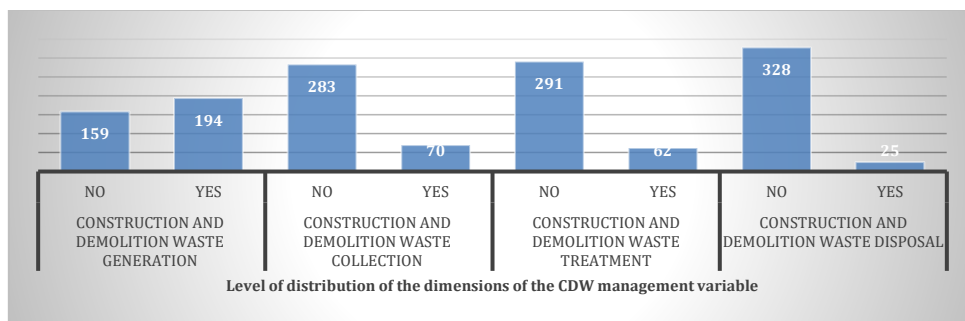


Fig. 2: Level of distribution of the dimensions of the CDW management variable

The variable tourism environmental sustainability, as presented in Fig. 3, has a frequency of occurrence of 46.70% in option no (n = 165) and a

yes to 53.30% (n = 188), this indicates that the population considers that good management of RCDs generates tourism environmental sustainability.

Note: Fig. 3 shows the responses taken by the inhabitants of Lunahuana on tourism environmental sustainability.

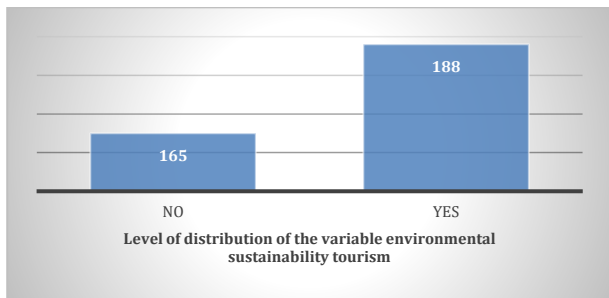


Fig. 3: Level of distribution of the variable environmental sustainability tourism

In examining the dimensions related to tour operators and their responses to the options "No" and "Yes," certain frequencies of occurrence emerge. Specifically, for the dimension concerning tour operators' engagement in responsible measures, 57.20% of respondents opted for "No" (n = 202), while 42.80% responded with "Yes" (n = 151). Consequently, it becomes apparent that more than half of these establishments do not undertake measures for the proper treatment of CDW.

Regarding the dimension associated with biological diversity, 40.50% of respondents favored "No" (n = 143), while 59.50% selected "Yes" (n = 210). This suggests that a majority believe that activities promoting the conservation of flora and fauna are indeed taking place.

Similarly, in the dimension related to environmental recovery, merely 7.90% of respondents chose "No" (n=28), with a substantial 92.10% responding with "Yes" (n=325). These data indicate that the population perceives an overall improvement in the environmental situation over time. Nonetheless, it remains essential to address ongoing environmental issues on a day-to-day basis.

The dimension concerning cultural identity exhibited a frequency of occurrence, with 45.60% responding "No" (n=161), while 54.40% chose "Yes" (n=192). This underscores the need for the population to reconsider their practices concerning RCD management for the greater benefit of the community. Additionally, efforts should be made to enhance and incorporate norms that facilitate responsible RCD treatment. Fig. 4 visually presents the dimensions of tour operators, biological diversity, environmental recovery, and cultural identity for reference.

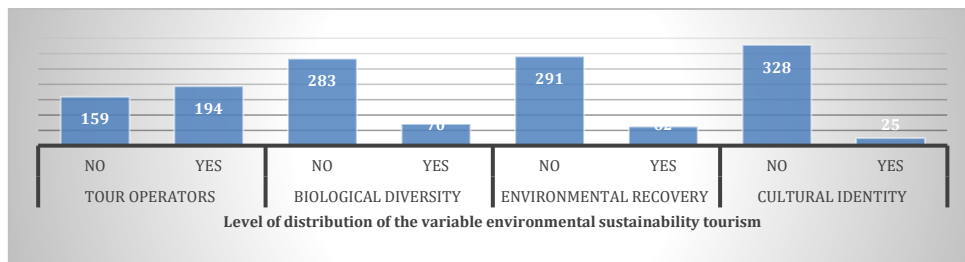


Fig. 4: Level of distribution of the variable environmental sustainability tourism

4.2. Contrasting hypotheses

Table 1 indicates that the Spearman correlation coefficient is positive and low between the variables, and is statistically significant, affirming that, the greater the management of construction and demolition waste, the greater the environmental sustainability of tourism. Table 2 illustrates that the correlation coefficient exhibits a positive and

moderate relationship, accompanied by a significance value lower than the threshold established for accepting the alternative hypothesis. This leads to the conclusion that there exists a direct relationship: as the management of CDW generation increases, so does the level of environmental sustainability within the domain of tourism.

Table 1: Correlation between CDR management and tourism environmental sustainability

Rho de Spearman	N	Correlation coefficient	Sig. (bilateral)	The correlation is significant at the level
V1: Construction and demolition waste management	353	.386	.000	0.01 (bilateral)
V2: Tourism environmental sustainability				

The correlation coefficient between the variables obtained through Spearman's Rho is presented

Table 2: Correlation between CDW generation management and tourism environmental sustainability

Rho de Spearman	N	Correlation coefficient	Sig. (bilateral)	The correlation is significant at the level
D1: CDR generation management	353	.613	.000	0.01 (bilateral)
V2: Tourism environmental sustainability				

The correlation coefficient is presented by applying Spearman's Rho

Table 3 indicates a positive Spearman correlation coefficient, low between the CDW collection management dimension and the variable tourism environmental sustainability, with a significance

value lower than that established to accept the alternate hypothesis, establishing that there is a relationship between them.

Table 3: Correlation between CDR management and tourism environmental sustainability

Rho de Spearman	N	Correlation coefficient	Sig. (bilateral)	The correlation is significant at the level
D2: CDR Collection Management V2: Tourism environmental sustainability	353	.352	.000	0.01 (bilateral)

The correlation coefficient is presented by applying Spearman's Rho

In [Table 4](#) we observe that the Spearman correlation coefficient is positive and low between the CDW treatment management dimension and the variable tourist environmental sustainability by obtaining a significance value of less than 0.05, thus confirming the alternative hypothesis by

establishing that there is a relationship between them. [Table 5](#) indicates that the Spearman correlation coefficient is positive and low between the CDW disposition management dimension and the variable tourism environmental sustainability.

Table 4: Correlation between CDW treatment management and tourism environmental sustainability

Rho de Spearman	N	Correlation coefficient	Sig. (bilateral)	The correlation is significant at the level
D3: CDR processing management V2: Tourism environmental sustainability	353	.283	.000	0.01 (bilateral)

The correlation coefficient is presented by applying Spearman's Rho

Table 5: Correlation between CDW disposition management and tourism environmental sustainability

Rho de Spearman	N	Correlation coefficient	Sig. (bilateral)	The correlation is significant at the level
D3: CDR Disposition Management V2: Tourism environmental sustainability	353	.192	.000	0.01 (bilateral)

The data correspond to the correlation coefficient applying Spearman's Rho

5. Discussion

The variable management of CDW reached negative percentage values of 81.6%, demonstrating that, if there is no good management of CDW there will be no tourism environmental sustainability and this is similar to what happens in the findings of [Flores and Adalid \(2019\)](#), who concluded that RCDs are the most harmful to the environment, since they mostly do not have an adequate final destination, and its disposal is in inappropriate places such as river banks, the main cause of overflows, to this, we must add the garbage is thrown away and informal constructions. On the other hand, [Abubakar et al. \(2022\)](#) determined that an adequate management proposal for the management of RCDs mitigates the risks of environmental pollution to opt for the sustainability of natural resources.

The management dimension of CDW generation represented that only 55% of the population takes measures by generating CDW demonstrating that it does not contribute to tourism environmental sustainability, results that are coincident with what was presented by [Abdel-Shafy and Mansour \(2018\)](#), who presented alternatives for environmental awareness and other activities to be developed for better waste management, whereas the diversity of attractions is affected if management activities are not improved.

The CDW collection management dimension showed that 80.2% of the population does not develop some management of CDW collection, aspects already presented by [Elshaboury et al. \(2022\)](#), who established the economic and environmental advantages generated by the good management of RCDs, suggesting implementing sustainable practices in the management of RCDs, highlighting the importance of environmental care based on sustainable tourism. The management dimension of CDW treatment resulted in 82.4% not

classifying or reusing RCDs, likewise, they do not know about regulations related to the treatment of RCDs. In this regard, it is concluded that the regulations that manage the RCDs in the Provincial Municipality of Cusco have legal gaps and are not integrated, It is necessary to modify them where it considers the study of management of RCDs as an indispensable requirement in the projects. A model was established to manage a sustainable city.

The management dimension of CDW disposition resulted in 92.9% indicating that there is no suitable destination or CDR collection center. [Purchase et al. \(2021\)](#) found this same flaw and their proposal was the reduction of the environmental impact produced by the RCDs, proposing and executing a management plan, which allowed them to manage well, Transport, collection, and final disposal, It is important to propose different ways to promote awareness in the population about the problems associated with this waste and promote its reuse.

6. Conclusion

The research findings have revealed that effective management of CDW is pivotal in ensuring the environmental sustainability of tourism. A proficient RCD management system plays a crucial role in preventing environmental damage to various settings, such as roads, riverbanks, sidewalks, residential fronts, and tourist service areas, thereby preserving their scenic beauty.

Moreover, the management of CDW generation facilitates strategic planning, enabling the implementation of essential measures for the efficient handling of CDWs. This approach ensures comprehensive monitoring of RCD-related activities, from their inception to their final disposition, with the primary objective of mitigating adverse consequences for both the local population and tourists.

Similarly, effective management of CDW collection serves to diminish the dispersal of RCDs, streamlining their proper collection, and contributing to environmental conservation. The management of CDW treatment should adhere to well-defined legislation, with a dual aim of raising public awareness and guiding individuals toward responsible use of natural resources.

Lastly, the management of RCD provision proves instrumental in promoting tourism environmental sustainability. By establishing secure and organized locations for RCD disposal, through collaborative agreements involving residents, authorities, and construction companies, it becomes evident that viable alternatives exist to prevent environmental pollution. These initiatives, in turn, support the sustainable development of the tourism industry.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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