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ENVIRONMENTAL MANAGEMENT MODEL FOR VERIFICATION OF AREAS DEGRADED BY SOLID CONSTRUCTION AND DEMOLITION WASTE IN ICA, 2021-2022.

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ABSTRACT
This article addresses the problems of solid construction and demolition waste (CDW) in Ica. Improper waste disposal has deteriorated natural and urban spaces, harming the landscape, health, and the environment. This occurs despite current regulations, such as Supreme Decree No. 002 - 2022 - Housing, but obstacles persist in technical capacity, environmental literacy, and oversight. Using a combined descriptive and exploratory approach, 50 deteriorated areas were selected and direct observation, surveys, georeferencing, and statistical analysis were implemented to assess the situation and establish an environmental management model. This model is divided into five elements: diagnosis, prevention, transportation, recovery, and oversight. It uses standardized technical sheets to ensure waste traceability and connect national regulations with local actions. It promotes shared responsibility and the circular economy. The results showed that its implementation simplifies the detection and recovery of critical areas, improves control of CDW flow, increases the recovery of reusable materials, and strengthens environmental governance. It was concluded that it is technically and regulatory feasible, adaptable to other contexts, and capable of transforming waste management into a preventive, comprehensive, and sustainable system, with social, environmental, economic, and institutional advantages.

Keywords: Environmental management, solid waste, oversight, environmental economics, sustainable development.

INTRODUCTION

The construction industry is one of the activities with the highest investment and therefore labor activity, infrastructure of all kinds is generated, satisfying the needs of people, it is a source of work, it promotes urban growth, but it exerts a lot of pressure on the environment, because there is a lot of consumption of natural resources (NRNR), such as the loss of spaces or alteration of their functions according to Roodman, cited by Valdivia (2009) construction is one of the activities with the greatest environmental impact, not because of what it emits, but because of the use of energy, basically the volume of solid waste that is produced. Research such as that of Ooshaksaraie and Mardookhpour (2011), asserts that most of this waste is reusable, although a minimal part has no value, but must be safely confined.

In industrialized countries, construction and demolition waste (CDW) management has made notable progress and it is its recycling and utilization systems that reach recovery rates in which more than 50% of the total generated is achieved, such as Denmark (52.6%), Germany (53.3%), France (70.2%), Luxembourg (84.5%), Malta (74.5%) and the United Kingdom (48%). In contrast, in those that are not industrialized, the levels of CDW recycling are zero, among the causes is the lack of effective policies, infrastructure and environmental culture that are important to address this problem.

In Latin America, facts that generate a growing problem, according to Jofra (2016), the region is increasingly urbanized, almost 80% of its population resides in cities and this urbanization process, added to the promising growth of construction and modernization of infrastructure, facilitates the sustained growth of CDW generation. but the institutional and technical management capacity is

limited, there are many informal dumps, degradation of natural and urban areas, and severe damage to public health.

In Peru, the trend is critical, the growth of the situation is not unrelated to this trend. The growth of the construction sector in recent years has brought with it an increase in CDW, especially in expanding urban areas, despite regulations such as D.S. No. 002 – 2022 - Housing, which is fragmented and lacks an articulated and preventive approach, in addition to a lack of effective oversight, little technical capacity of local governments and limited awareness of the actors involved. This gap between the regulatory framework and the operational reality generates a scenario in which CDW is frequently disposed of, uncontrollably, in public spaces, wastelands or natural areas, causing visual pollution, alteration of ecosystems and health risks.

In the province and department of Ica, the problem is visible, due to disorderly urban growth, which causes debris to accumulate unduly deteriorating the soils and landscapes, in addition to the loss of material that could be reused.

In view of this, an alternative is an environmental management model that executes systematic actions to verify degraded areas, evaluate their impact and establish prevention and control strategies, in accordance with current regulations, integrating technical tools and procedures to improve the effectiveness of public management and promote sustainable practices in the construction sector. In this way, the study will provide a solution that contributes to environmental sustainability, the improvement of territorial planning and the reduction of the risks associated with this growing problem.

Construction is an economic activity that impacts the environment (Roodman, cited by Valdivia, 2009), the construction industry generates large amounts of social media (Ooshaksaraie and Mardookhpour., 2011), some can be reused and others cannot, in developed and industrialized nations, recycling rates are high, unlike in non-industrialized countries, where they are almost zero (Valdivia, 2009)

In Europe, the growth of this industry reaches 2,503 million tons, while in Latin America, according to Jofra (2016) "The most urbanized region in the world is Latin America", population growth is generating large volumes of CDW, currently it is already a problem of critical environmental pollution, the problem worldwide and the little interest of governments in addressing them is confirmed.

Peru has a Regulation for the Management and Management of Waste from Construction and Demolition Activities and is regulated for the processes of generation, segregation, transport, reuse and final disposal of CDW in the national territory, however its non-compliance is evident, as it is noticeable in several areas that are affected. especially coastal wetlands, beach areas, among others, and the lack of dumps present in the country. Peru does not have and does not have dumps at the national level, which leads to an increase in this problem at the territorial level, there is no statistical information that shows all the problems because they do not have all the conditions and also the abandonment regardless of the volume of CDW generating impact on the environment. The question then becomes: How can the environmental management model contribute to eradicating areas degraded by CDW in the province of Ica, department of Ica? and others such as: How would the actions to verify areas degraded by CDW in the area of study be improved?, To what extent does the environmental management model allow the minimization of CDW contamination in the area of study? and Does the environmental management model strengthen the context of the current environmental regulations for the management and handling of CDW in D.S. 002-2022-Housing?; The goal is to: Design the environmental management model applied with verification actions to eradicate areas degraded by CDW in the province of Ica, department of Ica and with them answer the specific questions, it will serve to improve the concepts, criteria and approach related to the actions of verification of areas degraded by CDW (hereinafter ADR CDW). proposing verification actions that make it possible to know the degree of CDW contamination, directly responsible for the contamination, as well as establishing guidelines and strategies to reduce the deficit of this type of solid waste with

the implementation of dumps in the study area by identifying potential areas, in addition to having a model applicable to other contexts, that contributes to strengthening the verification actions of ADR and CDW in Peru, seeks to demonstrate the importance and validity of a methodology that combines qualitative and quantitative approaches, with the purpose of analyzing the relationships between human behavior and verification actions, proposing a more practical, economical, viable procedure that can be adapted to other scenarios that are necessary and address the unauthorized accumulation of CDW, both in urban areas and in fragile ecosystems of the national territory that face similar environmental problems,

The Environmental Management model from the perspective of ISO 14001:2025, provides a methodical framework for companies to recognize, monitor and reduce their environmental impact, this international standard meets several perspectives periodically evaluating the facts, but also applies preventive solutions instead of corrective ones, contributing to compliance with current legislation and reinforcing the environmental responsibility of companies (International Organization for Standardization, 2015).

Aspects such as Green technologies, according to Ramos et al. (2020), which combine the concepts of waste reduction, energy efficiency and use of NRNR in an effort to balance environmental preservation with economic growth, for Ramos et al. (2020) implementing them is a way to improve sustainability and institutional competitiveness, companies or entities comply with current environmental requirements, optimize processes and save operating costs through technological innovation, in this way green technologies consolidate their place as a vital instrument for the transition to a circular and low-carbon economy that can meet the environmental demands of the twenty-first century, all within the framework of the Circular Economy, this innovative model has already been adopted in many realities and is encourages the reuse of CDW in new products such as recycled aggregates, or high-strength bricks from CDW. There Tieppermann tells us: "The potential that this model has to achieve is enormous. The construction sector will have to change its economic model to this model in the near future and that the different agents and processes involved adapt appropriately" (Tieppermann, 2021, p. 7).

CDW are the leftover elements and materials that remain after the work is completed, these according to the type and magnitude of the work, can be made of various components. Regarding the definition of waste (Jofra Sora, 2016) he defines that: CDW is that which is generated during the development of a construction activity, the execution of civil works, demolitions or related activities. This is basically inert waste, consisting of mixed earth and aggregates, stones, concrete remains, asphalt pavement remains, refractory materials, bricks, glass, plastics, plaster, scrap metal, wood and in general all the waste produced by the movement of earth and construction of new buildings and infrastructures, as well as those generated by the demolition or repair of old buildings.
The following image shows us the real problem of CDW in peripheral Lima

Figure 1: Environmental contamination by CDW VES

Fountain. https://habemusdataperu.wordpress.com/2018/11/20/los-cerros-de-edilberto-ramos-contaminacion-ambiental-en-villa-el-salvador/

Table 1. Life Cycle of the constructions

The design phase	The construction phase	The demolition phase
During the construction project, the technician designs, locates, describes, quantifies and specifies the different elements used in the building.	The construction processes will determine the type and quantity of social media generated everywhere. During the first stages of the work, during the subsequent stage of receiving materials, during the storage stage, during the execution stage, during the demolition and reconstruction stage	At the end of a building's useful life, the waste generated depends on typology, construction criteria, construction procedures, materials used, demolition techniques

Source: Authors' elaboration taken from "Handbook of Recycled Concrete and Demolition Waste". Pag 29- 30

RCD Classification

Regarding the classification, NTP 400.050 (2017) indicates the classification of construction and demolition waste into Removal Surpluses, Construction Surpluses and Other Wastes

Figure 2. Sorting of waste from construction and demolition activity

Source: Authors' elaboration based on NTP 400.050.2017. Pg. 6. In the original Spanish language.

Hazardous construction and demolition waste is considered to be waste generated in these processes and that has at least one of the following characteristics: self-combustibility, explosiveness, corrosivity, reactivity, toxicity, radioactivity or pathogenicity, or that due to the treatment or finish to which it is or will be subjected, represents a significant risk to health or the environment.

Table 2. Classification of hazardous waste

Hazardous waste		
Residue	**Dangerous Elements**	**Dangerousness**
Treated Wood	Arsenic, lead, formaldehyde, pentachlorophenol	Toxic, flammable
Paint remover containers, aerosols	Methylene Chloride Trichloroethylene	Methylene Chloride Trichloroethylene

Containers of: grease removers, adhesives, paint removal liquids	Trichloroethylene	Flammable and toxic
Packaging: paints, pesticides, plywood, glues, lacquers	Formaldehyde	Toxic, corrosive.
Remains of fluorescent tubes, transformers, capacitors, etc.	Mercury, Polychlorinated biphenyls (BPC)	Toxic
Ceramic scraps, batteries	Nickel	Toxic
Oil filters, lubricant containers.	Hydrocarbon	Flammable, toxic

Source: Authors' elaboration based on D.S. 003-2013-VIVIENDA Annex 3, Published on Friday, February 8, 2013, Pg. 15.

Table 3. Classification of non-hazardous waste

Non-hazardous waste		
Recyclable and reusable elements from construction and demolition	Clean dismantling	Clearing as a result of the massive excavation of land for the foundation. Cyclopean concrete elements and demolition material consisting of lightened slabs and masonry partition elements containing wood, plastic elements, paper, cardboard and any other inorganic material that does not serve the purpose of consolidating the fill are not considered clean clearance
	Facilities	Fixed kitchen furniture Fixed bathroom furniture
	Covers	Roof tiles Skylights and skylights Prefabricated screeds Boards Sandwich boards
	Facade	Doors. Windows. Stone cladding. Precast concrete elements
	Interior partitions	Screens. Mobile or fixed partitions. Railings. Doors. Windows
	Interior Finish	Ceiling (plaster). Floating tiled floors. Decoration elements
	Structure	Beams and pillars. Precast concrete elements

Source: Based on DS 019-2016 - Housing Annex 4, Published on Friday, October 21, 2016, Pg. 7 and 8.

Table 4. General composition of the debris

General composition of the debris	
Type of waste	Type of waste
Bricks, tiles and other ceramics (54%)	Wood (4%)
Concrete (12%)	Plastic (1.5%)
Garbage (7%)	Glass (0.5%)
Stone (5%)	Paper (0.3%)
Asphalt (5%)	Gypsum (0.2%)
Sand, gravel and other aggregates (4%)	Other (4%)

Source: Adapted from Cabildo, 2012, Pg. 372

Construction and demolition waste processing

The CDW process is seen in a very dynamic way in the following scheme, in which the process of transfer and disposal finally takes place to places where recycling treatments can be carried out or, failing that, to authorized places (Bazán Garay, 2018).

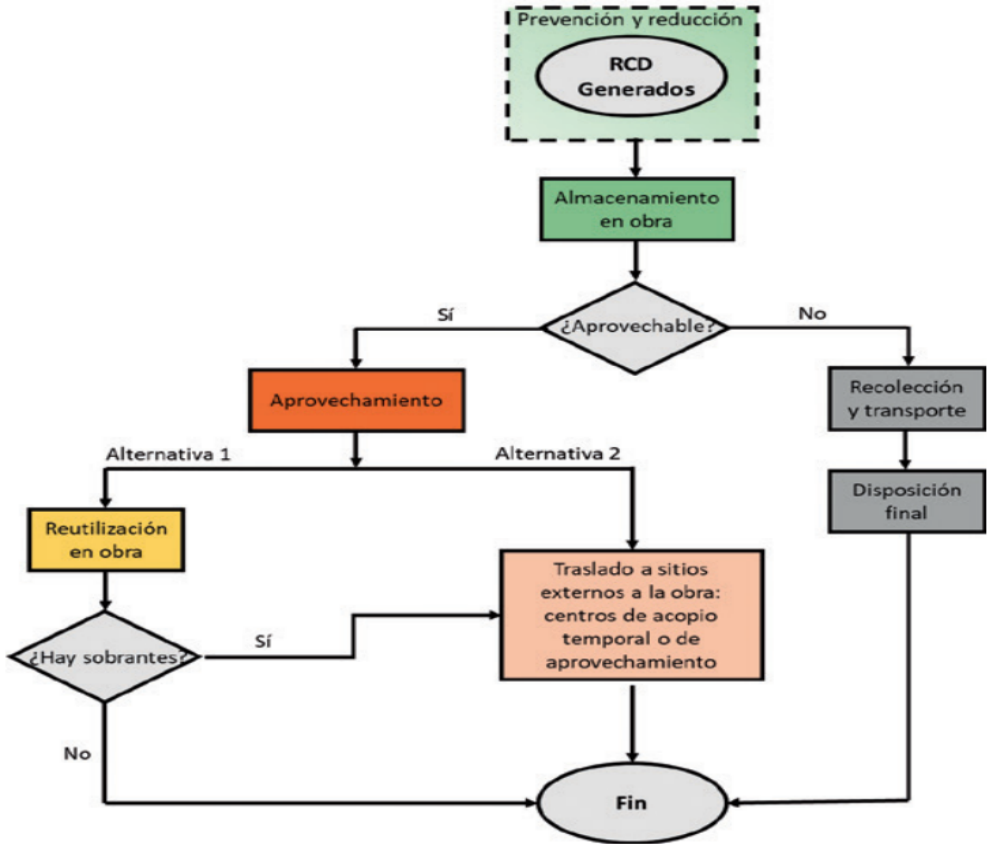

Figure 3. Flowchart of decisions for the production of construction and demolition waste generated on site

Fountain. Guide for the comprehensive management of construction and demolition waste in the city of Barranquilla. In the original Spanish language.

On the management of construction and demolition waste (Jofra Sora, 2016) he tells us that: "An environmental management policy for CDW must prioritise reduction, reuse and recycling, in accordance with the waste management hierarchy. And reduce the final disposal of waste to a minimum." Pg. 5 also Suárez Silgado, Andrés Molina, Mahecha, & Calderón, (2018) says: "Waste management is a vitally important issue to take into account in the policies and development plans of a locality. One of the necessary conditions to implement good waste management is a preliminary study or diagnosis on the generation of waste in the area."

In Peru, environmental regulations have evolved over time, currently in force D.L. No. 1501, Law of Integral Management of RRSS which modifies D.L. No. 1278; of 11/05/2020.

RESEARCH METHODOLOGY

The research was applied, with an explanatory level and non-experimental design, based on observation and the longitudinal type of trend since it will focus on analyzing the variables concerning the established years (Years 2021 and 2022). Corresponding to the observation of a certain fact.

Whose research variables are: Environmental Management Model and Areas degraded by construction and demolition social media, the Analysis Unit is the degraded areas of construction and demolition social media in the department of Ica, which also turn out to be the population and the sample made up of 50 sectors or areas degraded by construction and demolition waste (CDW) in the area of the department of Ica, sampled in a non-probabilistic way, but by judgment, based on technical and environmental criteria, considering those areas that presented characteristics representative of the problem, such as significant accumulation of waste, accessibility for verification and impact on ecosystems or urban areas.

Data collection techniques and instruments

Techniques

The technique to be used in the following research will be direct observation, since the verification of degraded areas will be carried out by social networks of construction and demolition in the area of the department of Ica.

On the other hand, surveys will be carried out with residents of the area in order to collect qualitative information and the perception they have regarding the topic to be developed.

Instruments

As part of the instruments, the CDR ADR inventory sheet will be used, as well as the support of satellite images of the intervention area that will facilitate the identification of the area degraded by CDW and determine its period of permanence.

With respect to the part for the demonstration of the truth or falsity of the hypotheses raised, statistical parameters were used with the support of the SPSS version 25 software and as part of the statistical analysis the functions of data correlation, T-Student and ANOVA analysis of variance will be used.

RESULTS

Presentation of the Environmental Management Model for Construction and Demolition Waste in the Province of Ica

The model is not limited only to controlling the final disposal of waste, but also integrates an approach to prevention, recovery and social participation, in accordance with the principles of integrated management of social networks. In this way, it seeks not only to reduce pollution and recover degraded areas, but also to promote the circular economy, take advantage of reusable materials and strengthen environmental institutions in the province.

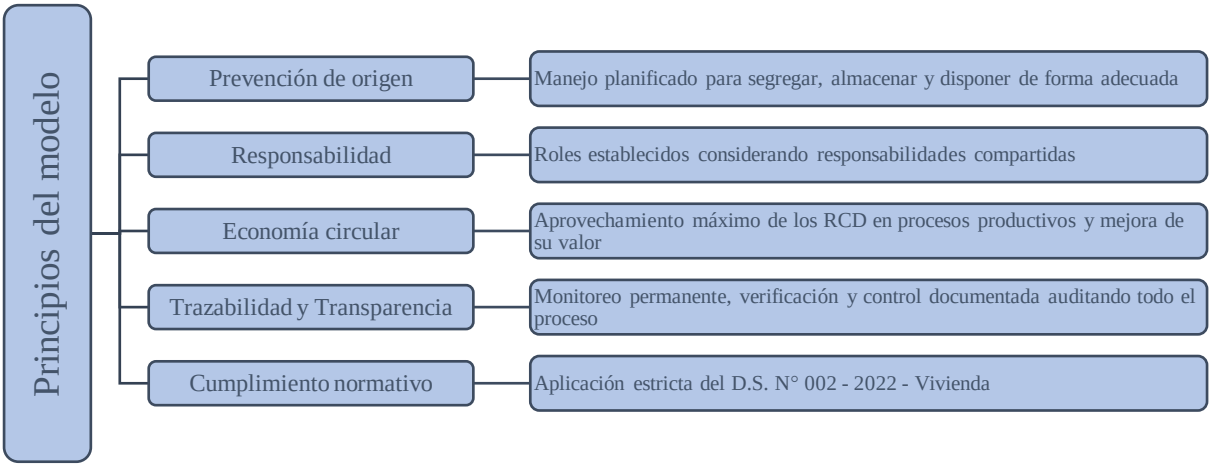

Figure 4. Principles of the model.

Fountain. Author's own elaboration. In the original Spanish language.

Table 5. Model structure

Component	Detail
Diagnosis and Verification of degraded areas	Applying the files to be able to appreciate and/or verify the conditions in general, understanding all the problems and building a database that allows us to take preventive actions and that glimpses the magnitude of the problem and promotes greater awareness of the community and the authorities.
Prevention on site	CDW management plan implemented to comply with all actions and provisions applied by the municipality and the building sector, preventing CDW from ending up anywhere but in places planned and destined in a safe way, minimizing the impact.

Component	Detail
Transportation and Final Disposal	Establishing that only authorized companies can transport and dispose of CDW in such a way that appropriate routes are traced using control sheets, volume, route and controlled destination, with this loss can be avoided, reducing the impact and safe use.
Valorisation and circular economy	Valuation of CDW for its full use, through agreements, service contracts, generating an organized use circuit of CDW, since it becomes a productive and profitable act, reducing the environmental burden, with economic benefits, transforming waste into useful inputs that are reincorporated into the production chain, promoting a scheme of environmental and economic sustainability.
Oversight and monitoring	Continuous inspection and monitoring, based on the premise of control, but being the environmental and management indicators, which allow measuring the effectiveness of the model in the reduction of degraded areas and in the prevention of pollution.

Source: Prepared by the author

Together, the five components of the model make up a comprehensive, dynamic and adaptable system, which allows addressing the problem of CDW in the province of Ica from a preventive, corrective and valorization approach. The use of technical sheets at each stage constitutes the operational axis of the model, ensuring that actions are documented in a standardized manner, reliable data are generated, and evidence-based decision-making is facilitated.

Management tools

Based on a strategic and objective function, there are documents that can verify the entire process, the main point being the technical verification sheets, which fulfill the function of standardizing the collection of information and documenting in an orderly manner the management of waste in its different stages, according to the following table:

Table 6. Management tools

Token	Detail	Purpose
Field Verification	Designed to record the integral conditions of the entire situation, prioritizing cleaning, recovery or control actions, classifying degraded areas by the level of damage: mild, moderate or severe.	It helps to define the order of intervention, directing the available resources towards the most critical points, making management more efficient and focused
On-site inspection	Designed to verify that the waste prevention and management measures contemplated in the work plans are complied with in practice.	It evaluates segregation, temporary storage in containers or spaces, marking of collection areas and compliance with regulations.
Transport and disposal	Designed to verify information on the type and volume transported, the company or person responsible for the transfer, the route used and the place of disposal or recovery.	It records the traceability of CDW, reducing informal practices. It is the central database that allows you to collect information on transported volumes, routes and regulatory compliance.
Valorization	Designed to record the volume of materials recovered and reincorporated into production processes. These files include information on the type of material recovered (concrete, bricks, metals, wood, among others), the amount recovered, the destination or	It assesses the impact of the model on the promotion of the circular economy and on reducing the volume of CDW destined for final disposal. It generates indicators that show the capacity of the system to transform waste into resources, contributing to the

Token	Detail	Purpose
	final use, and the company or entity that carried out the recovery.	environmental and economic sustainability of the province
Control	Implemented by the municipality or by the local management committee. Observes compliance with current regulations with respect to CDW.	It verifies compliance with the regulations and measures contemplated in the model in all its processes, the existence of sanctions applied and the degree of progress in the recovery of degraded areas.

Source: Researcher's own,

The periodic application of these files contributes to maintaining constant monitoring of the system, detecting deficiencies and applying timely corrective measures. In addition, they strengthen the role of local authorities in supervision and ensure that the model does not remain only at the theoretical level, but that it is translated into concrete and measurable actions

The application of these files allows not only to supervise, but also to generate a historical record of the management practices in each work, which constitutes useful evidence in case of sanctions or audits. It also promotes a culture of environmental responsibility in construction companies, by demonstrating that prevention measures on site are formally evaluated and monitored

Expected Benefits

A. Significant reduction of degraded areas due to inadequate waste disposal,
B. Adequate segregation, transport and final disposal of CDW,
C. Reduction of soil, air and water pollution,
D. Reduction of risks associated with the proliferation of vectors and the impact on ecosystems.
E. Improvement of the quality of life of the population, especially in peripheral urban areas that currently suffer from the accumulation of debris.
F. Recovery of these spaces will allow communities to have cleaner and safer areas,
G. Limit public health problems related to the presence of uncontrolled waste.
H. Involve citizens and waste pickers in the process,
I. Fostering a participatory environmental culture,
J. Active participation in the entire process, especially the monitoring and control of waste management,
K. Consolidation of a recovery circuit that transforms waste into useful resources,
L. Reuse of materials such as concrete, bricks, metals and wood not only reduces final disposal costs, generating income through their reincorporation into production processes.
M. Creation of secondary markets that generate formal employment, promote local enterprises and strengthen the circular economy.
N. Waste is no longer a problem but a source of opportunities.
O. It contributes to strengthening the management of public organizations,
P. The incorporation of instruments such as inspection, transport, valuation and inspection forms facilitates the work of supervision and provides the authorities with reliable and standardized information for decision-making.
Q. The creation of a local CDW management committee promotes inter-institutional coordination and avoids the fragmentation of responsibilities, which has been one of the main problems in waste management.
R. It consolidates the basis for a change of approach in CDW management, moving from a reactive scheme, based on the simple final disposal of waste, to a preventive, comprehensive and valorising system.
S. Responsible management of construction and demolition waste, making urban growth compatible with environmental protection and regulatory compliance, and legitimate and community-accepted demands.

Limitations and risks

A. It has been possible to identify:
B. Technical and budgetary capacity of the municipalities. Limitations in the operational load and the lack of budget allocated to environmental management.
C. Resistance of waste generators, especially construction companies and small informal builders. Non-application of CDW management plans and segregation or recovery measures, deliberate non-compliance with regulations.
D. Informal transport of CDW and clandestine dumping in vacant lands or natural spaces due to the lack of inter-institutional coordination or the existence of consolidated informality networks could reduce the effectiveness of the system.
E. There is little infrastructure available for the reuse of materials, there are no recycling plants or specialized recovery centers for CDW.
F. The incipient practice of environmental culture of the population and the actors involved, without a sustained cultural and educational change, the verification and inspection actions could become isolated measures without a real structural impact.
G. Political and institutional discontinuity, changes in authorities and officials do not allow for the sustainable development of policies and changes, generating setbacks in the recovery of degraded areas and in the recovery of materials.

Conclusions of the model

It is a proposal that develops practical strategies and mechanisms that facilitate the supervision, prevention and recovery of the materials generated in construction and demolition activities.

- The inclusion of technical sheets for verification, inspection, transport, recovery and inspection, which constitute the operational axis of the system, is a strength. The cards standardized observations and actions, since they generated reliable data and guided evidence-based decision-making.
- It is a preventive and valorizing approach, which is not only the final disposal of waste, but also contributes to the recovery of degraded areas and generates formal employment and improves the quality of life in the communities affected by uncontrolled dumping.
- Participatory system, based on shared responsibility between generators, transporters, valorizers, local authorities and citizens, avoiding that it is not only the responsibility of the municipalities but of all those involved, improving the viability and sustainability of the system.
- It identifies the limitations and risks that affect implementation: lack of municipal resources, resistance of actors, scarce infrastructure for valorization and limited environmental culture of the population, once these barriers were identified, mitigation strategies, training programs, incentives for formalization and inter-institutional cooperation were planned, ensuring that the model can be consolidated over time.

In conclusion, the environmental management model for CDW in the province of Ica is a realistic, adaptable and sustainable proposal, which articulates national regulations with specific prevention, control and recovery actions, reducing pollution and recovering degraded areas, in addition to laying the foundations for a more modern, participatory management system oriented towards sustainable development. This provides an effective response to local problems, while strengthening the institutional framework and contributing to the fulfillment of the country's environmental commitments.

Verification of degraded areas by social media of construction and demolition in the area of study.

It was possible to identify and define a set of technical actions for verification in the field that allow the recognition, classification and documentation of the degraded areas by construction and demolition social networks (CDW) within the scope of study. The verification process was structured through the

preparation and application of field technical sheets, which made it possible to standardize the collection of data at each point visited, including criteria such as: geographical location (with coordinates), type and estimated volume of waste, soil conditions, level of environmental impact, presence of polluting elements, proximity to populated areas and age of the deposit.

Table 7. Volumes of social networks of construction of the sampled points

Sampling Point	CDW (m3)
01 - District of Santiago	277.79
02 - Tate District	3790.91
03 - Tate District	9459.16
04 - /	154.95
05 - Pueblo Nuevo District	11443.94
06 - CP El Rosario - District of Los Aquijes	29770.24
07 - Los Aquijes District	6283.87
08 - Pueblo Nuevo District	32539.67
09 - District of Ica	59865.02
10 - District of Ica	11442.80
11 - District of Ica	8407.28
12 - District of Ica	73850.91
13 - Subtanjalla District	26126.37

Source: Compiled by the author.

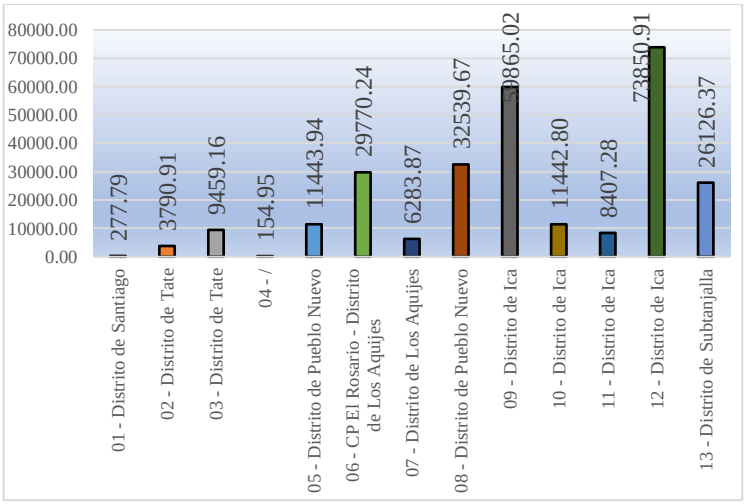

Figure N° 5. CDW volume at sample points

Source: Table 7. In the original Spanish language.

As can be seen in the table and figure shows us the average volumes of each sampled point that have been 13, the sum of these volumes gives an approximate total of 273412.89 m3 which is worrying in terms of the amount that has been found, there are points where the accumulation is quite high.

Evaluation of the effectiveness of the environmental management model in the prevention of social media pollution from construction and demolition in the area of study

The effectiveness of the environmental management model proposed for the management of construction and demolition waste (CDW) in the province of Ica was evaluated based on its capacity to reduce the inadequate disposal of materials, prevent the degradation of urban and peri-urban areas, and promote sustainable practices among actors linked to the construction sector. The evaluation was not limited to a theoretical appraisal, but was based on the results obtained in the previous diagnosis, the volumes of waste identified, the critical points recorded and the applicability of the verification data sheets as a central control instrument. What is visualized in the following aspects:

- Generation of reliable and systematized information. Confirming that the model corrects one of the most notorious weaknesses of environmental management at the local level: the lack of organized information that serves as a support for planning and decision-making.
- The model allowed the identification and classification of degraded areas according to their level of affectation (mild, moderate or severe), allowing appropriate decisions to be made.
- Reduction of impacts due to the accumulation of CDW and affected areas.
- Incorporation of citizen participation in the verification of degraded areas is another element that reflects the effectiveness of the model.
- The potential of the model for the recovery of CDW, recognising the materials and critical points for greater use, promoting segregation on site and the recovery of materials.
- Promoting a preventive approach constitutes evidence of its effectiveness, since it shifts the emphasis from simple cleaning to the reduction in the generation of waste and its economic use.
- Construction of management indicators (derived from the diagnosis) and verification sheets, as well as strategies for the recognition of identified degraded areas, volume of accumulated waste, proportion of recoverable materials and recidivism rate at critical points.
- Generating a preventive approach that generates corrective actions, such as isolated cleaning campaigns, proposes a comprehensive approach that includes: on-site planning, segregation of materials, community control and waste recovery, the change of perspective constituting one of the greatest achievements of the proposal, since it allows preventing the generation of impacts and avoiding recidivism in the sites already recovered.

Factors such as economic and logistical resources, scarce infrastructure for recycling, recovery of CDW and resistance of some actors represent risks that can reduce the effectiveness of the model if they are not accompanied by incentive policies, continuous training and inter-institutional cooperation mechanisms. And with respect to the environmental issue, it constitutes controlling the dispersion of waste in urban and peri-urban areas, recovering degraded spaces, reducing risks to public health, promoting recovery practices, reducing the demand for virgin materials and promoting a circular economy in the construction sector, which confirms the importance of the model in the environmental field. economic and social.

Analysis of the direct relationship of the environmental management model with the current environmental regulations for the management and management of social networks for construction and demolition D.S. 002-2022-VIVIENDA.

Under the premise of the validity of D.S. No. 002 – 2022 – Housing, it allows:

- To establish the specific provisions for the management and handling of construction and demolition waste (CDW), within this legal framework, the analysis of the relationship between the proposed model and the current regulations is key to determine its feasibility, legitimacy and applicability in the field of study.
- It upholds the extended responsibility of all CDW generators, whether they are construction companies, public entities or individuals, to comply with an adequate management of CDW from the planning stage of the work to the final disposal, which implies the prevention of the damage that they may cause,
- It promotes the recovery of waste, which recovers useful materials through reuse, recycling or co-processing, in fact, it has been evidenced with the diagnosis that approximately 60% of the waste identified corresponds to materials such as concrete and brick, which are highly recoverable. Therefore, the model not only complies with regulations, but also generates added value by turning an environmental liability into an economic opportunity.
- It establishes the supervised role of municipalities towards generators, with the use of verification sheets that include a georeferencing system of critical points that facilitate municipal control and planning, strengthening the institutional capacity of local governments, promoting transparency in monitoring and facilitating compliance with the regulatory mandate.

- The basic point is the establishment of the principle of prevention that must be a priority, a situation that the environmental management model must prioritize, among other aspects, makes it more important and efficient.
- This model proposes instruments and techniques that allow a better performance of all those involved, managers, inspectors and generators that can materialize in concrete and effective actions.
- It incorporates the circular economy principle into the management of the manager and generator, which reduces the pressure on NRNRs and encourages the creation of new value chains, with the facts already explained above, transforming the model into an opportunity for innovation and local economic development.
- It considers the sanctioning and oversight role foreseen, the model contributes to generating a registration system through the files that can really apply these processes in a truly effective way.
- This environmental management model proposed in this study is directly articulated with the guidelines established by the standard not only from a technical level, but also in its social and economic repercussions, the main contribution is to understand that CDW is an integral problem, it is not only about cleaning, but also about how it affects the health of the population. the security of urban environments and territorial planning. At this point, the model presented responds to the normative mandate by proposing mechanisms that affect the prevention of health and environmental risks, while promoting a more efficient management of resources.
- In the social sphere, the relationship between the model and the regulations is reflected in the promotion of safer and healthier urban environments, in which the degraded areas where CDW accumulates expose the population in peripheral areas or on wasteland, the regulation expressly establishes the need to guarantee the protection of public health through adequate CDW management, and the proposed management model contributes to this objective by systematizing the identification and classification of the most critical areas. In this way, full coherence is achieved between the standard and the model, since both coincide in prioritizing the safety and well-being of the population as the axis of environmental management.
- On the economic level, the relationship is also evident. The regulation establishes that the recovery of CDW should become a priority strategy to reduce the volumes of final disposal, according to which it proposes mechanisms of segregation and recovery on site, reducing the environmental burden on landfills and degraded areas, in addition to considering the possibility of generating new value chains for materials from CDW. they can be reincorporated into secondary production processes, reducing the demand for virgin raw materials. This direct relationship with the circular economy approach included in the regulations shows that the model is not limited to complying with legal formalities, but also enhances the economic benefits of its application.
- Likewise, the regulation recognizes the importance of shared responsibility among the actors involved in the life cycle of CDW: generators, transporters, valorizers, municipalities and the community in general, the model responds to the need for active participation of the population in the verification and control of critical points, promoting the co-responsibility of companies and local governments. In this way, it is evident that the model complements the provisions of the law by establishing concrete channels of social participation, which strengthens environmental governance and legitimizes the inspection processes.
- The relationship between regulations and territorial planning is key, it establishes that local governments can incorporate CDW management within their urban planning and management instruments, the model in this regard provides high value, since the database prepared with verification sheets and the map of critical points that constitute tools that are directly integrated into the urban and environmental development plan of the province, confirms that the model complies with the standard, facilitates its practical application in the territory, ensuring that waste management ceases to be an isolated process to become a transversal component of urban planning.

- The relationship between the model and the regulations can also be analyzed from the perspective of efficiency in the use of public resources, in which the standard establishes the implementation of mechanisms for the control and recovery of degraded areas, the model proposes clear indicators (volume of waste, number of critical points, level of affectation), establishes that resources must be allocated rationally, prioritizing areas of greater impact. This articulation is essential, as it prevents limited municipal budgets from being diluted in ineffective actions, and ensures that compliance with the regulations translates into tangible results for the population.
- The model is aligned with the regulations in the principle of transparency and traceability of waste management, it establishes that the generators would document and support the final destination of the CDW, which implies a verifiable monitoring of their management. The verification sheets designed in this study fulfill precisely that function, since they record in a standardized way data on origin, volume, type of material and environmental conditions, generating traceability that ensures regulatory compliance and facilitates environmental management with technical and documentary support that strengthens the inspection and audit processes. the model offers concrete solutions to the structural weaknesses faced by the municipal management of CDW, this relationship of complementarity ensures that the proposal proposed is not legally viable, is technically and socially relevant, guarantees that its implementation effectively contributes to the prevention of pollution, the recovery of degraded areas and the transition towards a more sustainable urban development model.

DISCUSSION OF RESULTS

The analysis of the results obtained from the verification of areas degraded by construction and demolition waste (CDW) in the province of Ica allows us to clearly recognize the magnitude of the environmental problem that these materials generate when they are not properly managed. Through the application of field technical sheets, thirteen critical points were identified, whose accumulation of waste amounts to an approximate volume of 273,412,893 m³. This alarming figure in itself is concrete evidence that CDW represents one of the main sources of urban and peri-urban environmental deterioration in the region, affecting both soil quality and the landscape and the health of the surrounding population.

The methodology applied provided a differential value to the study, since it allowed obtaining systematized, georeferenced and documented data in real time, which until now did not exist as an official record. This aspect is key because it reveals that the problem of CDW, although recognized, had lacked a precise technical basis that would serve as a basis for decision-making. The collection of information also showed that waste is not distributed homogeneously, but is concentrated in peripheral or easily accessible areas, where municipal inspection is scarce or non-existent. These findings confirm that poor waste management responds to recurrent patterns that are maintained over time, reproducing degradation processes in the same spaces.

The presence of CDW is not only a visible environmental problem, it reveals structural flaws in the planning of urban growth and in territorial management, the volumes are concentrated as the urbanization advances, which occurs in a disorderly manner, without provision for collection or unauthorized transport routes for construction waste, generating a problem that does not assume preventive mechanisms in local urban planning.

The weak articulation between the actors responsible for waste management, the model made shared responsibility possible and the need for institutional coordination were evidenced, this finding specifies that the problem cannot be reduced to a technical issue, it involves aspects of governance and inter-institutional management that must be addressed to achieve an effective solution.

Another aspect is that the magnitude of the waste identified at each critical point reflects socioeconomic dynamics linked to the growth of the construction sector, the growth of buildings and infrastructure projects generating a growing volume of CDW, if the management chain is efficient, it ends up in unauthorized spaces, so these results become a wake-up call to link CDW management with urban development and housing policies in the region.

Finally, the general interpretation of the data shows that the problem of CDW transcends the strictly environmental field and is connected to the citizen perception of the quality of public management, the population perceives abandonment and loses confidence in management, in addition to this, pernicious habits are generated by accepting this reality and not being able to reverse it. the dump is not only for CDW but for waste of other kinds. The management of CDW is not only a technical challenge, it is also social and political, it is essential that the population recovers credibility in management and development of environmental culture.

The volumes found allow us to measure the environmental impact of inadequate CDW management. The 273,000 cubic meters at critical points are not just visible debris, but reflect pressure on NRNR and urban ecosystems. The disposition of these materials alters the hydrological cycle, obstructs natural drains, reduces soil permeability and contributes to erosion in wastelands, the composition and volume of CDW at critical points is variable and the degree of affectation is according to this variation, subsequent situations, such as the emergence of informal dumps, animals, humidity and people of poor living are part of this collateral problem, to which is added the presence of polluting materials mixed among the waste, which increases the risk and environmental affectation, these confirm that CDW is not inert waste, but that its polluting potential is high, it becomes an informal dump of mixed waste and this affects the environment, It reduces the quality of life and the efforts to manage them are disadvantaged by their exponential growth and the limited capacity of local management.

The relationship between volume and critical point provides information to decide on the control of negative environmental impacts, even more so if there is a risk of flooding that will generate dragging of materials into bodies of water, obstruction of canals, consequently affecting the use of water domestically and agriculturally.

In addition, it is appreciated that the degradation of the landscape also affects the quality of life and reduces the value of the land, the disorderly growth generates that potentially habitable areas become devalued and unattractive spaces, useful spaces are lost because they occupy space for other infrastructures: green areas or recreational and service areas, for this reason the management model was generated that contemplates or includes in a plan the recovery and valorization of these materials.

The model is effective because, according to its development, it allows the forecasting, the formal location of collection and transfer points of CDW, makes the model a contribution to be able to georeference and verify the facts, supporting the actions of control, sanction or environmental recovery, increasing the efficiency of public management, responding to address the shortcomings, complementing the activities, solving the difficulties, the model will reduce the number of informal dumps, but it will also promote the use of materials in new production chains, reducing the pressure on ecosystems, from preventive strategies of segregation of CDW, recovery of debris and formal transport, the circular economy is promoted, it is also effective because it defines from the standardized files the data required to propose solutions, progressively strengthening institutional capacities', allows the identification of dumps and others that arise in time and establishes actions to be able to address the problem, coordinate surveillance and co-responsibility to address and suppress the recidivism or appearance of new sources of accumulation, promotes environmental awareness in the population.

In the social sphere, it is about generating a better quality of life for the inhabitants, prioritizing actions according to volumes and complexity of the products, recovering degraded areas that generates a positive perception of the citizenry. The spaces freed from waste can be used for community uses, generating social cohesion and contributing to the strengthening of the sense of belonging in the population, in addition to the habits that are acquired when there is an accumulation of CDW nearby, it becomes the informal space to dispose of domestic social networks, a situation that must be uprooted in people, on the positive side, it is the opportunity to involve the community in management and generate co-responsibilities.

Economically, it generates savings for management, since once the critical points are identified and the problem is defined, it acts efficiently, reducing operating costs and the possibility of taking

advantage of CDW arises, generating additional income from the commercialization of recycled materials. This perspective reinforces the financial sustainability of the system and provides municipalities with a realistic alternative to address the magnitude of the problem.

The research also shows the need to strengthen the institutional framework in the management of CDW. Local governments are responsible for monitoring and sanctioning, but the volumes found show that their current capacities are limited. The lack of technical personnel, equipment and financial resources largely explains the proliferation of informal dumps.

The proposed model provides a practical solution to this institutional deficit, by providing a system of registration and control that can be implemented with relative ease. The checksheets standardize the process and generate databases that allow municipalities to plan interventions more effectively. In addition, the integration of citizens as a monitoring agent strengthens environmental governance, creating a more participatory and legitimate system.

CONCLUSIONS

- The magnitude of the CDW problem in the province of Ica is critical and shows a deficiency in the current management. The total volume identified in the thirteen sampled points exceeds 273 thousand m^3 of waste, which represents a significant environmental risk to soils, water bodies and the quality of life of the population. This finding confirms the urgency of implementing systematic and sustainable management mechanisms.
- The use of verification sheets was consolidated as an effective instrument for collecting information in the field. Its application made it possible to standardize registration criteria, classify degraded areas and generate a reliable database that served as an input for the construction of the environmental management model. This methodology ensures that the results are not limited to isolated perceptions, but reflect the real situation of the territory with technical evidence.
- The proposed environmental management model demonstrated effectiveness in the prevention of CDW contamination. The statistical analyses carried out in SPSS (Student's t-test, Chi-square and correlations) confirmed that there is a significant difference in the reduction of waste volumes when verification and control actions are applied, as well as a direct relationship between the number of interventions and the reduction of critical points. In this way, the general hypothesis of the research is validated.
- The current regulations (D.S. 002-2022-VIVIENDA) find in the model a practical tool for its application. While the standard establishes the guidelines for the management and handling of CDW, the model provides operational instruments that allow municipalities to comply with their responsibilities of inspection, proper disposal and recovery of waste. This articulation strengthens environmental governance and contributes to reducing the gap between the legal framework and local practice.
- The environmental, social and economic impacts associated with CDW can be mitigated through the implementation of the model. On the environmental level, the reduction of informal dumps contributes to the recovery of degraded spaces; at the social level, citizen perception of the authorities is improved and risks to public health are reduced; On the economic level, it opens up the possibility of revaluing materials as productive inputs, generating additional benefits to the community.
- The research shows that it is possible to transform CDW management into an opportunity for urban sustainability. Although the results show a complex and large-scale problem, they also confirm that with simple technical tools, citizen participation and institutional commitment, it is feasible to implement a management model that not only controls the inadequate disposal of waste, but also promotes circular economy and sustainable development practices.

RECOMMENDATIONS

- Immediate implementation of the environmental management model at the municipal level. Given the magnitude of the waste identified, it is recommended that local governments adopt the

verification sheets as an official instrument for the collection and monitoring of information, ensuring the continuity and periodic updating of the data.

- Strengthen inter-institutional coordination. It is necessary for the Regional Government, the provincial and district municipalities, as well as the Ministry of Housing, to work together in the application of D.S. 002-2022-VIVIENDA, using the proposed model as a practical tool for coordination and oversight.
- Promote programmes for the recovery of construction and demolition waste. It is suggested to promote the recycling and reuse of materials such as concrete, brick or asphalt, integrating construction companies and formal recyclers, in order to reduce the pressure on landfills and generate local economic benefits.
- Continuous training for the technical staff of the municipalities. To ensure the correct application of the model, it is essential to train the environmental inspection and management teams in the use of verification sheets, georeferencing and data analysis.
- Promote citizen participation and community policing. It is recommended to design awareness campaigns and citizen complaint channels that allow the identification and reporting of clandestine dumps, strengthening social co-responsibility in the management of CDW.
- Specific budget allocation for CDW management. It is advisable for local authorities to include in their annual operational plans exclusive items to finance control, transport, final disposal and recovery of areas degraded by CDW.
- Periodic monitoring and evaluation of the management model. Finally, it is recommended to establish clear performance indicators (reduction of volumes, number of critical points recovered, quantity of materials recovered) that allow evaluating the effectiveness of the model in the medium and long term, making adjustments when necessary.

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