Ciencia Latina Revista Científica Multidisciplinar, Ciudad de México, México.
ISSN 2707-2207 / ISSN 2707-2215 (en línea), marzo-abril 2024,
Volumen 8, Número 2.

https://doi.org/10.37811/cl_rcm.v8i2

ENVIRONMENTAL MANAGEMENT PLAN AND WATER REUSE WASTE IN A METALLURGICAL COMPANY, PERU, 2023

PLAN DE GESTIÓN AMBIENTAL Y REÚSO DE AGUA RESIDUOS EN UNA EMPRESA METALÚRGICA, PERÚ, 2023

Jasmin Fidelia Herrera Jimenez
Cesar Vallejo University, Peru

DOI: https://doi.org/10.37811/cl_rcm.v8i2.11159

Environmental Management Plan and Water Reuse Waste in a Metallurgical Company, Peru, 2023

Jasmin Fidelia Herrera Jimenez[1]
jfjimenez@ucvvirtual.edu.pe
https://orcid.org/0009-0005-1280-115X
Cesar Vallejo University
Peru

ABSTRACT

The main objective of the research was to determine how the Environmental Management Plan improves the reuse of wastewater generated by a steel company, Pisco 2023. The approach of the research was with the methodology of applied type and experimental design, proposed the solution of a practical problem through the application of the environmental management plan, and the intervention with the pre and post-test evaluations. The population and sample consisted of 15 records (5 weeks pretest January-March and 5 weeks posttest May-July 2023). From the sample, the 15 paired means (pretest and post-test) were determined. Data collection was conducted using documentary analysis techniques and instruments: checklist and registration sheets. Statistical analysis with SPSS 22 software determined that implementation of the environmental management plan improved the wastewater reuse rate from 6.41 to 15.73. It was determined that the implementation of the environmental management plan significantly improved the reuse of wastewater generated by a steel company, Pisco 2023.

***Keywords*:** *environmental management, reuse, wastewater*

[1] Autor principal
Correspondencia: jfjimenez@ucvvirtual.edu.pe

Plan de Gestión Ambiental y Reúso de Agua Residuos en una Empresa Metalúrgica, Perú, 2023

RESUMEN

El objetivo principal de la investigación fue determinar cómo el Plan de Manejo Ambiental mejora el reúso de aguas residuales generadas por una empresa siderúrgica, Pisco 2023. El enfoque de la investigación fue con la metodología de tipo aplicado y diseño experimental, se propuso la solución de un método práctico. problema mediante la aplicación del plan de manejo ambiental, y la intervención con las evaluaciones pre y post-test. La población y muestra estuvo compuesta por 15 registros (5 semanas pretest enero-marzo y 5 semanas postest mayo-julio 2023). A partir de la muestra se determinaron las 15 medias pareadas (pretest y postest). La recolección de datos se realizó mediante técnicas e instrumentos de análisis documental: lista de verificación y hojas de registro. El análisis estadístico con el software SPSS 22 determinó que la implementación del plan de manejo ambiental mejoró la tasa de reúso de aguas residuales de 6,41 a 15,73. Se determinó que la implementación del plan de manejo ambiental mejoró significativamente el reúso de aguas residuales generadas por una empresa siderúrgica, Pisco 2023.

Palabras clave: *gestión ambiental, reutilización, aguas residuales*

Artículo recibido 26 marzo 2024

Aceptado para publicación: 25 abril 2024

INTRODUCTION

In the context of the world, the scarcity and environmental degradation of water are problems that increase the priority of water management, evidencing the need for more developed management strategies, taking into account what has been stated by UNESCO, that seventy percent of industrial wastewater is dumped untreated, due to the existence of difficulties in industries to meet the strict requirements of discharge and reuse of water (Lyu, 2023; Rodríguez et al., 2021; Smol et al., 2020). The economic growth of the global industrial sector is a latent concern since it degrades and immensely affects the environment, moreover, that industries lack effective environmental management plans conducive to mitigating environmental pollution with good practices such as lower consumption of raw materials, reducing waste, treating wastewater, and controlling pollution levels. representing the reuse of wastewater, an effective and suitable alternative option for saving the resource, minimizing environmental impact, reducing costs and energy use (Naqvi, 2023; Sa'ad et al., 2022), this reinforces the urgent need for wastewater reuse, enabling access to water resources in restricted places and prevention of the future scenario, which is projected towards the year 2050, when global consumption will double (Ahmed et al., 2022; Jodar et al. 2019).

However, recent advances in wastewater treatment and reuse have led to a high efficiency in the removal of various hazardous pollutants, due to the advances acquired in wastewater reuse technologies and applications, despite this, there are still significant efforts to be made for its implementation worldwide. the primary motivation for water recycling was to supplement scarce resources and provide alternatives to surface water effluent disposal (Takeuchi & Tanaka, 2020; Ahmed et al., 2022). Water reuse is a virtuous solution that protects nature by limiting the risks of pollution discharges into the environment and strengthens water self-sufficiency by providing (Olivieri et al., 2020; Ghernaout et al, 2019; Lee & Mendoza, 2022; Maquet, 2020).

In Peru, the aforementioned problems are also present in the industrial sector, where 60% of companies do not implement environmental management tools, generating management conflicts, do not assign control measures and prevent major impacts; in addition, weak environmental management was implemented, with communication problems observed due to its processes, which do not require clear environmental goals and objectives, and little initiative is shown in research and management negative

environmental impacts (Torres, 2022). Considering that the reuse of wastewater is an essential component to sustainably manage water resources, recent studies of environmental performance in the country, linked to the current reality of the levels of wastewater generated, identified that 40% of the wastewater identified in industries involved prior treatment to its discharge into a receiving source. The main causes of the inadequate quality of reused water resources are insufficient treatments, discharges of untreated wastewater, inadequate solid waste management, environmental liabilities, and their characteristics (Cáceres, 2023; Páucar and Iturregui, 2020).

The steel company carries out its activities in the Ica region, for the application of its industrial processes of manufacture of construction iron, it uses the water resource, which is obtained through the extraction of tube wells and is collected in the main reservoir R8, called source water, which is diverted to the reverse osmosis plant where the process of purification and elimination of solids is applied for use in the construction industry. In the production areas, after the treatment has been conducted in the POI, 2 output streams are generated as a product: permeated water and reject water. The steel company with its growing demand exerts pressure on natural water sources, significantly increasing the pressure of water consumption, as well as the sustained increase in the volume of wastewater discharged in the area of oxidation lagoons, and the greater extension of them, leading to higher levels of soil and air pollution that corresponds to the areas surrounding these wastewater deposits. containing high concentration levels of metals and pollutants. If the sustained increase in these water, air and soil quality indices is not remedied, they would generate an irreversible impact on the areas of influence, and it is essential to apply an effective environmental management plan that develops an efficient reuse of reclaimed water for industrial use in the field of circular economy to reduce the consumption of natural water and increase the reuse of industrial wastewater used by the steel company for its operations. production processes.

In this problematic reality, PG was identified as a general problem How does the Environmental Management Plan improve the reuse of wastewater generated by a steel company, Pisco 2023? The research was justified by theoretical value criteria because it increased knowledge by generalizing the results to broader principles to know the behavior of the variables and their relationship. With the criterion of convenience, it is useful to improve the effectiveness of the use of the environmental

resource, benefiting the company through better processes and reducing its costs. Due to its social relevance, it is transcendent for society, since it benefited workers and the population, encouraged the creation of environmental awareness with good practices and their application. Due to practical implications, it contributed to the solution of the problem of environmental impact in influence. The overall objective was to determine how the Environmental Management Plan improves the reuse of wastewater generated by a steel company, Pisco 2023, The general hypothesis was: HG The Environmental Management Plan significantly improves the reuse of wastewater generated by a steel company, Pisco 2023.

THEORETICAL FRAMEWORK

Environmental management

From the point of view of theories related to environmentalism, there are four currents, the first focused on utilitarianism and property rights, enabling the market to regulate natural resources, based on economic efficiency, whose analytical instrument is cost and benefit. On the other hand, the second current focuses on preservation and intangible ecology, proposes that human beings have no right over natural resources and there are borders imposed by nature, this perspective is reactive to the effect of economic modeling that does not consider the ethical, social or moral aspect, proposing management with minimal intervention in the constitution of nature (Vidal and Asuaga, 2021). Likewise, a third position, the conservationist, emphasizes its perception of the resource and the environmental problem as restricting economic growth, supporting steady-state growth. Culminating with the fourth position, of sustainable development, which advocates a firm commitment of resources and environmental problems to the management of economic growth, in other words, the environmentalist position emerged in the 1980s, which holds that protecting the environment and the growth of the economy are combined in the reconciliation of ecology and the market economy (Vidal and Asuaga, 2021).

From the theoretical aspect, for Cuadrado and Vargas (2018) Environmental management addresses as its primary purpose to develop the best environmental intervention, through the process of continuous improvement, with the purpose of determining the best practices and processes to minimize the environmental impact of the organization, controlling the aspects derived from its operations, as well as the permanent monitoring of the impact on the environment. identifying the causes and mitigating

their inherent effects (Cuadrado & Vargas, 2018) A management plan points out the environmental deficiencies of each organization and proposes effective measures that contribute to the reduction of environmental impact, framing each organization to recognize what actions should be applied to mitigate the effects on the environment beyond the short term. and sustainable (Mohammad et al., 2020). In 1989, Pearce and Turner argued for the need for a new paradigm in the context of a circular economy, whose economic, social and environmental model represents a new challenge for organizations, considering that it represents the establishment of an economic system, in search of the preservation of natural resources, whose purpose is to contribute to the reduction of the environmental impact of development. increase the efficient and sustainable use of resources; and a better level of stakeholder well-being (Almeida & Diaz, 2020).

Environmental Management Plan

A sustainable environmental management plan is a comprehensive plan that specifies the steps to minimize the impact that human activity generates on the environment, likewise, to mitigate environmental degradation and conserve natural resources, to achieve its purposes, the plan incorporates environmental considerations in decision-making in the industrial field (Navqi et al., 2023). The benefits resulting from the implementation of an environmental plan are increased competitiveness and effectiveness linked to waste management, conservation of environmental resources, avoiding non-compliance with regulations by avoiding fines or sanctions, as well as creating, promoting, and stimulating environmental awareness, through good environmental practices and their implementation. The Environmental Management Plan was based on the continuous improvement cycle that combines the concepts of Plan, Do, Verify and Act (PHVA). Plan: The first phase that identifies the necessary environmental goals and processes. The environmental management organization established the objectives considering the company's environmental policy (Mosquera, 2022). Whose indicators are identification of objectives and processes Do: How the second phase implements the processes. Once the objectives have been defined, the necessary activities are conducted to achieve them, in accordance with the scheduled and stipulated times (Mosquera, 2022). Taking as indicators: programming and development of activities. Verify: To establish monitoring and measurement processes; constantly monitor the operations conducted, looking for opportunities for improvement that guaranteed the

continuity of the application over time, linked to the achievement of greater benefits for the organization and its stakeholders (Mosquera, 2022). Taking as indicators: monitoring and measurement. Acting: This is the phase where decisions are made to improve continuously. Based on the previous stage and once formulated, the action plan continues its execution, in pursuit of feedback and restart of the cycle (Mosquera, 2022). Taking as indicators the action plan and the continuous improvement process.

Wastewater reuse

From the aspect of related theories, the conceptualization of the term reuse, of wastewater, Cáceres (2023) argues that it is the use and use of previously used water destined for new application with the established requirements, that water reuse is the subsequent use of previously used water, understanding that wastewater is artificially modified contaminated water (removal of metal components, etc.) requiring treatment prior to discharge into the environment. The 2017 UN Water Resource Development Report was dedicated to wastewater, defined as the "untapped resource". Theimperative need for the efficient treatment of wastewater, its preservation as well as that of natural sources, guaranteeing its availability as a scarce resource, through its reuse due to its limitations for the use of water resources, its deficient quality, and as the main cause of pollution has the discharge of domestic wastewater (Páucar and Iturregui, 2020). Sustainable Development Goal (SDG) six is to ensure the availability and sustainable management of water and sanitation for all, with 50% of untreated wastewater and increasing the application of recycling and reuse globally. Reuse increases the volumes of water as well as the availability of water resources, improving the quality of effluents as a fundamental element in the management and use of water. Thus, reclaimed water is a substitute for use that requires minimum levels of quality, leaving better quality volume for primary uses, as well as for the most demanding (Antunes & Pasold, 2019).

Wastewater is the water volumes whose origin characteristics are modified by human activity or the particular use that was given to it, but not those that have undergone any modification due to natural causes or events (Cáceres, 2023) and according to what Sauri and Arahuetes (2019) maintain, wastewater requires advanced treatment that adapts the physical and chemical parameters to future uses, depending on effluent characteristics and quality, developing through the combination of the treatments

they require. In the research, direct reuse wastewater is that which is destined for industrial processes, both manufacturing and cleaning. The reused water is operationalized as an additional water resource derived from an industrial purification process.

Antunes and Pasold (2019) assume that planned indirect water reuse and planned direct water reuse are applied. Dimensions: Direct reuse of wastewater: This occurs when effluents, after treatment, are routed directly from their discharge point to the place of reuse, without being expelled into the environment. This is the most common case, leading to industrial use (Antunes & Pasold, 2019). Indirect reuse of wastewater: This occurs when effluents, after treatment, are discharged into surface water in a planned manner, being used properly controlled, ensuring that the treated effluent is subject to the quality requirement at its destination (Antunes & Pasold, 2019).

METHODOLOGY

It was developed through an explanatory scope research, applied type and experimental design with pre-experimental sub-design. Thesample consisted of 15 pairs of measurements (pre-test and post-test) to determine the analysis. The techniques applied were observation and documentary analysis, the main instrument being the record sheet, which developed both techniques with procedures applied by the researcher.

RESULTS

With respect to the general objective, the implementation of the environmental management plan significantly improved the reuse of wastewater generated at the Pisco steel company, 2023, where the pre-test average obtained an index of 6.4067 and the post-test average registered 15.7267, determining its increase by 9.32. The inferential results expressed at the significance level of 0.000 obtained, led to the rejection of the null hypothesis and acceptance of the alternative hypothesis based on the decision rule ($p< 0.05$), determining that the application of the environmental management plan significantly improved the reuse of the wastewater generated in the Pisco steel company. 2023. These results are related to those presented by Morocho (2021), who showed that the implementation of the EMS, linked to the 14001:2015 standard, had a favorable impact on complying with environmental provisions, resource and waste management, generating a better economic valuation of the company, implementing

efficient environmental management. From the theoretical aspect, it corroborates what was stated by Alzate (2019) who pointed out that environmental management is defined as a conglomerate of strategies and actions from the preventive or corrective aspect that must be assumed in the face of risk, and Vidal and Asuaga (2021), who affirm that with sustainable development environmental management is carried out that make economic growth and the environment compatible, Within the framework of a new paradigm based on a circular economy, whose economic, social and environmental model entails a new challenge for all countries and organizations, considering that it represents the establishment of an economic system, in search of the preservation of natural resources, whose objective is to contribute to the reduction of the environmental impact of development, increase the efficient and sustainable use of resources; and better level of stakeholder welfare expounded by Pearce and Turner (1989) From the aspect of related theories, the conceptualization of the term reuse, of wastewater, Cáceres (2023) argues that the use of previously used water destined for new application with the established requirements, that water reuse is the subsequent use of previously used water, understanding that wastewater is modified contaminated water (removal of metal components, etc.) requiring treatment prior to discharge into the environment. Based on the above, it was determined that the reuse of industrial water increases the volumes of water as the availability of water resources, improves the quality of effluents as a fundamental element in the management and use of water. Thus, reclaimed water is a substitute for use that requires minimum levels of quality, leaving better quality volume for primary uses, as well as for the most demanding (Antunes & Pasold, 2019).

Table 1. Paired-means statistics for wastewater reuse.

		Media	N	Standard deviation	Mean standard error
Par 1	Pre-test wastewater reuse rate	6,4067	15	0,82416	0,21280
	Post-test wastewater reuse rate t	15,7267	15	0,98595	0,25457

Table 2. *T*-Student test paired samples Wastewater Reuse

	Matched differences					t	gl	Sig. (bilateral)
	Media	Standard deviation	Mean standard error	95% confidence interval of the difference				
				Inferior	Superior			
Par 1 Pretest wastewater reuse rate - Posttest wastewater reuse rate	9,3200	1,28074	0,33068	8,61	10,03	28,18	14	,000

According to Table 1, it was evidenced that the pre-test mean (6.4067) is lower than the post-test means (15.7267), which led to the acceptance of the alternative hypothesis Ha: The Environmental Management Plan significantly improves the reuse of wastewater generated by a steel company Pisco, 2023. Then, in order to validate the previous result, it is checked by means of the significance analysis, which is determinative according to the decision rule: If *p* value > 0.05, acceptance of the null hypothesis is decided; and in case, if *p* value ≤ 0.05, acceptance of the alternative hypothesis is decided. According to the result of Table 2, the level sig. *p= 0.000 obtained with the T-Student test validated the alternative hypothesis* The Environmental Management Plan significantly improves the reuse of wastewater generated by a steel company Pisco, 2023.

CONCLUSIONS AND RECOMMENDATIONS

The implementation of the environmental management plan significantly improved the reuse of wastewater generated by the steel company, Pisco 2023, where the pre-test average obtained an index of 3.58 and the post-test average registered 4.18 with an increase of 53.96%; the average valuation of the reuse of wastewater generated by the steel company. The inferential results expressed at the significance level of 0.000 obtained, led to the rejection of the null hypothesis and acceptance of the alternative hypothesis based on the decision rule (p< 0.05), determining that the application of the environmental management plan significantly improved the reuse of the wastewater generated in a Pisco steel company. 2023. It is recommended that the company consolidate and strengthen environmental management plans in the context of the circular economy, in order to significantly reduce the growing demand on natural water sources, and reduce the volume of wastewater discharged in the area of oxidation lagoons, and the greater extension of them, mitigating the levels of soil and air pollution in the areas surrounding wastewater deposits, containing high concentration levels of metals and pollutants.

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