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Effect of Compliance with Environmental Regulations in the Construction of Public Civil Works, Cajamarca, Peru

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ABSTRACT

Construction activities produce considerable environmental effects and have resulted in a growing demand to implement favorable environmental practices. In this sense, this research aimed to evaluate the effect of the level of compliance with environmental regulations in public civil works in the San Ignacio, Cajamarca, Peru district. Data were obtained through direct observation and structured interviews in 7 selected construction sites. The deductive and analytical method was used. As a result, the level of compliance was obtained. Work 4 had the highest rank, and works 2 and 5 had the lowest. Currently, all the works are in a similar range of compliance. The degree of association between the level of compliance with environmental regulations and the current state of the civil works indicates a probability of 0.0190, which shows that the low level of compliance with environmental regulations in the construction of public civil works in the district of San Ignacio generates a deterioration in the quality of the environment and increases the possibility of administrative sanctions.

INTRODUCTION

Worldwide, the ongoing trends of population growth and urbanization generate a constant increase in construction work (Asare 2022). In Peru, there are a large number of public civil works that are executed in different areas of the country to improve the living conditions of the population (Casavielles et al. 2011), these works may be directed by regional and local governments, which are responsible for hiring those in charge of the execution, depending on the magnitude of the work (Indahningrum et al. 2020). De La O Muñoz (2020) states that, in the construction process, the company or contractor must comply with the activities inherent to its competence according to the costs established in the Environmental Management and Management Plan.

It is also important to identify the main problems that affect the environment of the works (Enshassi et al. 2014) to establish management measures based on the incorporation of programs and guidelines that include prevention strategies and control and mitigation measures of the environmental impacts generated around the works (Corazi 2017). Dust generation, noise pollution, operations with vegetation removal, and air pollution are the most significant environmental impacts of construction projects (Enshassi et al. 2014). Civil construction works impact flora and fauna depending on their nature and extent (Hashemkhani et al. 2018).

In this sense, this study posed the question: what will be the effect of the level of compliance with environmental regulations? In relation to this, it was evaluated with criteria such as the Environmental Management Plan, Environmental Surveillance Plan, Contingency Plan, Solid Waste Minimization and Management Plan (PMMRS), and the Community Relations and Environmental Compensation Plan (Plan de Relaciones Comunitarias y Compensación Ambiental).

Based on the above, the objective of this research was to evaluate the effect of the level of compliance with environmental regulations in the construction of public civil works in the district of San Ignacio in the Cajamarca region,

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2021, to ensure environmental viability and counteract the negative effects generated by the execution of public civil works.

MATERIALS AND METHODS

Scope of the Study

The research was conducted in San Ignacio's district, department of Cajamarca - Peru. Seven public civil works were chosen, taking as criteria that all of them were in the process of execution (Work 1: San Ignacio, Work 2: San Ignacio, Work 3: San Ignacio, Work 4: San Ignacio, Work 5: Caserío Los Lirios, Work 6: Caserío Atapaca, Work 7: Caserío Ihuamaca, Work 8: Caserío Ihuamaca, Work 8: Caserío Ihuamaca).

The method used was the analytical deductive method (McKibben et al. 2020). The characterization of environmental regulations was determined by reviewing national legal bodies, such as norms, regulations, and guidelines related to compliance with environmental criteria in the construction of public civil works of educational, transportation, hydraulic, and urban infrastructure. The level of compliance with environmental regulations was obtained through frequency distribution and percentage analysis of data using the Non-Parametric Bidimensional Friedman Test. The data were collected by identifying the public civil works under construction (execution) in the district of San Ignacio through the Infrastructure and Territorial Development Management of the Provincial Municipality of San Ignacio.

The interviews were based on 5 criteria (Environmental Management Plan, Environmental Monitoring Plan, Contingency Plan, Solid Waste Minimization and Management Plan (PMMRS), and Community Relations and Environmental Compensation Plan). The application group was the resident, supervisor, or environmental specialist of the designated works, with the purpose of knowing the level of compliance with environmental regulations in the construction of public civil works. Likewise, to perceive the current state in situ of the works, a tour was made through each of them, where direct observation was made, taking into account the 5 criteria applied in the interview. Spearman's rank correlation coefficient was used to analyze the effect of the level of compliance with environmental regulations based on the data obtained from the scales for measuring the variables established (Table 1).

Table 1: Variables Measurement Scale.

Compliance Level	Current State of Public Civil Works
1 = Very bad	0 - 20 = Very por
2 = Malo	20 - 40 = Deficient
3 = Regular	40 - 60 = Regular
4 = Good	60 - 80 = Good
5 = Very Good	80 - 100 = Excellent

The data were processed with the Statistics V 8.0 statistical package (Análisis et al. 2012), and contingency tables were prepared to characterize the environmental regulations in the execution of public civil works. Frequency distribution tables were constructed, and a percentage data analysis was performed to identify compliance with environmental regulations in the construction of public civil works. Spearman's ordinal rank correlation coefficient was calculated to estimate the degree of association between the variables' level of compliance with environmental regulations and the current state of construction of public civil works, as well as Friedman's test to detect differences between the works with respect to the level of compliance with environmental regulations and the criteria defined for the evaluation.

RESULTS

The characterization of environmental regulations was based on three categories: 6 laws, 5 regulations, and a guide for preparing the Environmental Management Strategy (Table 2).

The level of compliance with environmental regulations shows that Works 4 has the highest level of compliance, while Works 2 and 5 have the lowest level of compliance. On the other hand, Criterion 4 has the highest level of compliance. Criterion 3 has the lowest level of compliance (Table 3).

According to the two-dimensional Friedman Test for the current status, there is no significant difference, so all works are at the same level of compliance. At the same time, Criterion 1 has the highest level of compliance for the current status, and Criterion 4 has the lowest level of compliance for the current status (Table 4).

The degree of association between the variables' level of compliance with environmental regulations and the current state of the civil works was significant, which translates into a tendency to a directly proportional behavior between the variables, i.e., the higher the level of compliance with environmental regulations, the better the current state of the civil works, and vice versa (Table 5). The probability of 0.0190 shows a significant difference between the two variables.

DISCUSSION

Strict laws should be enacted where institutions conduct

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Table 2: Characterization of Environmental Regulations.

Laws	Regulations	Guides
Law N°28611 - General Environmental Law.	Supreme Decree N°019-2009-MINAM - Regulation of the National System of Environmental Impact Assessment.	Environmental Management Strategy in the Framework of the National Environmental Impact Assessment System - Ministerial Resolution N°019-2020-MINAM
Law No. 28245 - Framework Law of the National Environmental Management System.	Supreme Decree N°008-2005-PCM - Regulation of the National Environmental Management System Framework Law.	
Law N°27446 - National Environmental Impact Assessment System Law.	Supreme Decree N°057-2004-PCM - Regulation of the General Law on Solid Waste.	
Law N°29968 - Law of the National Environmental Certification Service for Sustainable Investments.	Supreme Decree N°003-2013-VIVIENDA - Regulations for the Management and Handling of Waste from Construction and Demolition Activities - Supreme Decree Nº019-2016-VIVIENDA amending the regulations.	
Law No. 29325 - Law of the National Environmental Assessment and Control System.	Peruvian Technical Standard NTP 900.058 2019.	
Legislative Decree N°1278 - Law on Integral Solid Waste Management, Legislative Decree 1501, which amends the Law on Integral Solid Waste Management.		

Table 3: Level of Compliance with Environmental Regulations.

Statistical Test for the Construction Site	
Chi-square, corrected for ties	20.77
Degree of freedom	6
Probability	0.0020 (**)
Construction work	Meaning of Rank
1	3.20
2	2.00
3	4.80
4	6.40
5	2.00
6	5.30
7	4.30
Statistical Test for Criterion	
Chi-square, corrected for ties	10.70
Degree of freedom	4
Probability	0.0301 (*)
Criteria	Meaning of Rank
1	3.71
2	3.29
3	1.93
4	3.79
5	2.29

NS: Not Significant; P < 0.05; S: Significant; P > 0.05 (*); AS: Highly Significant; P > 0.01 (**)

Environmental Impact Assessments (EIA) in the early stages of civil works construction to reduce the negative impacts they may generate (Enshassi et al. 2014). EIAs should be evaluated objectively, implemented well, and

Table 4: Current Status of Public Civil Works.

Statistical Test for Construction Site	
Chi-square, corrected for ties	12.47
Degree of freedom	6
Probability	0.0522
Construction Work	Meaning of Rank
1	3.20
2	2.40
3	4.20
4	6.00
5	3.00
6	4.70
7	4.50
Statistical Test for Criterion	
Chi-square, corrected for ties	12.80
Degree of freedom	4
Probability	0.0123 (*)
Criteria	Meaning of Rank
1	4.29
2	3.43
3	2.57
4	2.00
5	2.71

NS: No Significant; P < 0.05; S: Significant P > 0.05 (*); AS: Highly Significant P > 0.01 (**).

Table 5: Effect of the Level of Compliance on Public Civil Works in the District of San Ignacio.

	Compliance Level
Current Status	0.8829
Probability	0.0190 (*)

NS: No Significant; P < 0.05; S: Significant; P > 0.05 (*); AS: Highly Significant; P > 0.01 (**)

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avoided personal interests (Crawley & Aho 1999, Wu et al. 2011).

Therefore, in this research, through the characterization of environmental regulations, it is confirmed that in Peru, environmental laws regulate the construction sector through compliance with environmental management instruments and should be interpreted correctly to avoid biases in decision-making. Likewise, public and effective participation must be guaranteed (Badr 2009).

The execution of the various works has caused a large part of the environmental components, such as soil, air, and biota of the areas of affluence, to be altered (Çelik et al. 2017, Xue et al. 2015). Therefore it recommends implementing and complying with environmental monitoring programs to control possible negative impacts on the physical, biotic environment and the environment of human interest (Opoku 2019). However, these present a compliance deficit, as shown in the results obtained based on the Score for Work in Compliance Level, where a probability of 0.0020 was obtained, indicating a highly significant difference between the 7 works compared, in which points to work 4 with the highest level of compliance and works 2 and 5 with the lowest level of compliance, resulting in the environmental impacts being negative or positive according to their compliance range.

Dust generation, noise pollution, operations with vegetation removal, and air pollution are the most significant environmental impacts of construction projects (Mok et al. 2015). There are various origins for producing environmental impacts (Mohammed et al. 2022). Such impacts originated from excavation, earth movement, and mobilization of machinery and equipment (Asare 2022, Shehadeh et al. 2022). With the 7 projects evaluated, it could be evidenced by many authors.

On the other hand, a very important factor to consider is the management of Construction and Demolition Waste (CDW) within the construction sites causes serious pollution on a global scale (Rondinel-Oviedo 2021, Wang et al. 2020). The government and the parties involved in the management and handling of CDW are in the adaptation process, so the current management is still very incipient (Chen et al. 2019). We agreed that criterion 4 is related to the Solid Waste Minimization and Management Plan, which has the lowest level for the current state of the construction site. In other words, it points to inadequate CDW management in the construction sites of our study.

Finally, the degree of association between the level of compliance with environmental regulations and the current state of the civil works indicates a probability of 0.0190, showing a significant difference between both variables. In other words, the higher the level of compliance with environmental regulations, the better the current state of the work, and vice versa. Therefore, implementing appropriate business practices in environmental management related to infrastructure works contributes to the sustainability of the environment.

CONCLUSION

When the level of compliance with environmental regulations is higher, there are low rates of environmental impacts in the construction of such works. On the other hand, if the level of compliance with environmental regulations is lower, there is the possibility of finding greater environmental aspects altered by the works, generating additional administrative sanctions.

The public civil works in the district of San Ignacio, according to the level of compliance, work 4 presented the highest level of compliance and works 2 and 5 the lowest, criterion 4 the highest level of compliance, and criterion 3 the lowest. On the other hand, for the current status of the work, it was verified that all the works are at a similar level of compliance. Criterion 1 has the highest level, and criterion 4 has the lowest.

The degree of association between the variables' level of compliance with environmental regulations and the current state of the civil works was significant, which translates into a tendency to a directly proportional behavior between the variables, i.e., the higher the level of compliance with environmental regulations, the better the current state of the civil works, and vice versa.

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