



## ASPHALT PAVEMENT MANAGEMENT AND ADMINISTRATIVE CONTROL: CASE STUDY IN LIMA, PERÚ

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### Abstract

The activities underlying the construction, operation and maintenance of road infrastructures are notorious for the large amount of natural materials and energy resources they consume, as well as for the significant environmental impacts they generate. The objective of the research was to analyze the relationship between asphalt pavement management and administrative control for the sustainability of asphalt pavements in the province of Lima, Peru. A quantitative research was carried out through the historical-logical method, theoretical triangulation and modeling were used with a sample of 160 workers from the company Cala Pavimentos y Construcciones EIRL., of San Juan de Miraflores. The technique applied was the survey that included socioeconomic characteristics, pavement management, administrative control, existing practices of the company and the improvements applied. The results show that there is a direct relationship between administrative control for sustainability and timely maintenance of asphalt pavements with a ratio of Spearman's Rho = 0.474 positive with a moderate correlation level, likewise a significance level of  $p = 0.000 < 0.01$  was obtained, which allows demonstrating that the relationship is significant. It was demonstrated that there is a direct relationship between asphalt pavement management and administrative control for the detection of failures of the company cala pavements and constructions with a high level of correlation in the sustainable management of asphalt pavements. A shift towards a more environmentally and economically responsible behavior in the field of construction and management of road pavements generates the need to develop and implement comprehensive management for sustainable pavement engineering.

**Keywords:** Alfato, Pavement, Administrative control, Sustainable management, sustainability of pavements.

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## **1. Introduction**

It is now known that the road transport system plays a fundamental and strategic role in the economic and social development of a country [1]. For the purposes of better road management, ordinary and extraordinary maintenance interventions are carried out to ensure that the pavement maintains specific functional and structural characteristics throughout its useful life [2]. The implementation of a pavement management system requires the definition of appropriate maintenance criteria and condition indicators, the monitoring of the condition of road pavement, and the archiving and processing of data to plan and schedule maintenance interventions [3, 4].

Several studies have been conducted to analyse the benefits of establishing proper maintenance planning; for example, the study by Tavakoli et al. [5] shows that without using an effective maintenance program, a city can see the cost of maintaining its transportation system increase in the future to four or five times what it would cost if proper maintenance were done earlier. Pavement indices have been developed based on the aggregation of various types of deterioration to measure overall pavement condition, agency-specific pavement condition data collection procedures, and deterioration rating protocols [8]. For example, the Federal Highway Administration (FHWA) road inventory program for the National Park Service (NPS) uses the Pavement Condition Rating (PCR), a combination of pavement surface deterioration and pavement roughness, as a weighted combination of the contribution of both components [6]. However, the structural condition of the pavement affects the performance of the pavement and knowledge of the structural condition is vital for pavement management at both network and project level [7]. A significant number of agencies, companies and organisations have adopted a sustainable approach that focuses on economic, environmental and social impacts in planning and decision-making [8]; In this sense, pavement management has become increasingly important as roads age and deteriorate over time. On the one hand, roads have been designed and built for a useful life and it is necessary to take actions to increase their service cycle; On the other hand, funding levels are becoming increasingly limited and better resource management is needed to accommodate a comprehensive mobility system largely focused on road use [9]. Pavement management is a discipline that encompasses activities related to the planning, design, construction, evaluation and maintenance of pavements in a road network [10]. Background studies in pavement management and sustainability have examined programs to recommend network

maintenance treatments based on general pavement surface conditions, structural conditions, and other performance indicators [11]. It is important to mention that this research applies the concept of pavement management of roads, highways and main roads. However, few studies have applied pavement management activities at the corporate management level [12, 13] that demonstrate its reliability and administrative control. The study aimed to identify the relationship between Administrative Control and Asphalt Maintenance in the context of a construction company.

## **2. Methodology**

### **Data collection and sampling**

The study is a non-experimental correlational cross-sectional type. The initial stage of this study was based on a literature review and research with the aim of identifying the relationship of Administrative Control and Asphalt Maintenance in the context of a construction company. The sample population of the study were 160 workers of the company *Cala Pavimentos y Construcciones EIRL.*, of San Juan de Miraflores, Lima, Peru, 2021. The data collected was processed and verified to be complete to ensure that all questions were fully completed.

The case firm studied for this investigation is one of the stable and fast-growing construction companies with its numerous ongoing and future industrial, infrastructure and residential construction projects in Lima, Peru. Taking into account that this company develops the most important aspects of administrative control for better control and growth of small and medium-sized companies in the field of paving tracks, infrastructure and industrial, including numerous associated projects, it could be considered as a good general representative of the construction companies operating in the city of Lima.

### **Measuring instruments**

The study followed a four-point Likert scale technique. A structured and closed questionnaire was used for respondents, (Likert scale: Never: 1, Almost never: 2 Sometimes: 3, Almost always: 4, Always: 5). For data analysis, a spreadsheet was used to describe the characteristics of the variables and dimensions of administrative control at the level of operational control, Concurrent control and feedback control, while the maintenance variable had dimensions for corrective, preventive, opportunity, failures, design, replacement and general repair maintenance.

### **Data analysis techniques**

In this study, the data have been analyzed in two steps. In the first step, primary and secondary data were analyzed through various statistical tools and

techniques, consisting of exploratory, correlation and mean factor analysis. ANOVA has been applied to analyze primary data as it explores the percentage of variance explained by each factor, along with the load value of each element. In addition, the study employed principal component analyses to reduce Likert scale biases for the model. In the second step, regression was executed to find out if administrative control and maintenance have any impact on the pavement management of the RSL company. This study also applied Cronbach's alpha coefficient (AC) and composite reliability to measure data consistency and reliability.

### 3. Results

The results of the interviews have shown that less than half of the interviewees knew about administrative control. Most, after a brief introduction, expressed that proper planning of control and maintenance are the most important and effective practices, among others, for a pavement management in a company. Most on-site workers agree that additional information on pavement management should be provided, highlighting that they are aware that they have a low knowledge of pavement management and feel the need to improve through training and proper practices. In addition, both managers and on-site workers believe that lack of motivation is another major reason why pavement management is not done properly on site. The results of the administrative control are shown in Table 1.

Table 1. Distribution of administrative control of the company Cala pavimentos y construcciones EIRL.

Variable 1	Low		Moderate		High	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Administrative control	18	22,5	30	37,5	32	40,0
Concurrent controls	17	21,3	25	31,3	38	47,5
Feedback control	20	25,0	19	23,8	41	51,3

Table 1 shows that 40% (32 workers) have a high knowledge of administrative control, 38% (30 workers) have a moderate knowledge of administrative control, while 22% (18 workers) have a low knowledge. Likewise, it is observed that 48% (38 workers) have knowledge of concurrent control in a high way, 31% (25 workers) have moderate knowledge of concurrent control while 21% (17 workers) have low knowledge of concurrent control.

Table 1 also shows that 51.30% (41 workers) have a high knowledge of feedback control, 23.80% (19

workers) have moderate knowledge of feedback control while 25% (20 workers) have low knowledge of feedback control.

#### Description of the results of the basic knowledge dimension on maintenance of the company Cala Pavimentos y construcciones EIRL

Table 2 shows that 52.50% (42 workers) have maintenance knowledge, 37.50% (30 workers) have moderate knowledge, while 10.00% (22 workers) have low maintenance knowledge.

Table 2. Distribution of the maintenance of the company Cala pavements and constructions EIRL

Variable 1	Low		Moderate		High	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Maintenance	8	10,0	30	37,5	42	52,5
Corrective	28	35,0	25	31,3	27	33,8
Preventive	8	10,0	15	18,8	57	71,3
Opportunity	13	16,3	28	35,0	39	48,8
Fault detection	1	1,3	5	6,3	74	92,5
Design modification	11	13,8	36	45,0	33	41,3
General repair	6	7,5	16	20,0	58	72,5
Replacement	5	6,3	27	33,8	48	60,0

However, the correct maintenance dimension shows that 33.8% (27 workers) have knowledge of

corrective maintenance in a high way, 31.3% (25 workers) have moderate knowledge of corrective

maintenance, while 35% (28 workers) have low knowledge of the CM. In preventive maintenance it was found that 71% (57 workers) have knowledge of preventive maintenance in a high way, 19% (15 workers) have a moderate knowledge of preventive maintenance while 10% (8 workers) have a low knowledge of preventive maintenance. While 48.80% (39 workers) have a high average knowledge of the maintenance opportunity, 35% (28 workers) have a moderate knowledge of the maintenance opportunity and 16.30% (13 workers) do not know what the maintenance opportunity is. Table 2 also shows that 92.5% (74 workers) have a high average knowledge of fault detection, 6.3% (5 workers) have moderate knowledge of fault detection, and 1.30% (1 worker) do not know what fault detection is. It is also shown that 41% (33 workers) have a high average knowledge of design modification, 45% (36 workers) have moderate knowledge of design modification, and 14% (11 workers) do not know what design modification is. At the design modification level, it was found that 73% (58 workers) have a high average knowledge of

design modification, 20% (16 workers) have moderate knowledge of design modification, and 7% (6 workers) do not know what design modification is. While 60% (48 workers) have replacement knowledge, 33.8% (27 workers) have replacement knowledge and 6.3% (5 workers) have low knowledge.

**Importance and correlation between the administrative control and maintenance of asphalt of the company Cala pavements and constructions EIRL**

In Table 3, it is observed that the value of  $p = 0.000$  is less than 0.05 therefore rejects the null hypothesis and accepts the alternative hypothesis (hypothesis of the researcher), that is, there is a relationship between the Administrative Control and the maintenance of asphalt of the company Cala Pavimentos y construcciones EIRL – San Juan de Miraflores 2017 and given the value of the correlation coefficient rho de Spearman = .376 according to the Bisquerra scale, this correlation is Moderate

Table 3 Importance and correlation between administrative control and maintenance of the pavements and cove constructions of the EIRL company

			ADMINISTRATIVE CONTROL	CORRECTIVE MAINTENANCE
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	,376**
		Sig. (bilateral)		.001
		N	80	80
	CORRECTIVE MAINTENANCE	Correlation coefficient	,376**	1.000
		Sig. (bilateral)	.001	
		N	80	80

\*\* The correlation is significant at level 0.01 (2 tails).

Importance and correlation between administrative control and corrective maintenance of the company Cala pavimentos y construcciones EIRL.

From Table 4: it is observed that the value of  $p = 0.001$  therefore the null hypothesis is rejected and the alternative hypothesis is accepted (hypothesis of

the researcher), that is, there is a relationship between the maintenance control and the corrective maintenance of the company cala pavements and constructions EIRL – San Juan de Miraflores 2017; and given the value of the correlation coefficient Rho sperman = 0.376 according to the Bisquerra scale, this correlation is casual

Table 4 Significance and correlation between administrative control and operational control of the pavements and cove constructions of the EIRL company

			ADMINISTRATIVE CONTROL	CORRECTIVE MAINTENANCE

Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.376**
		Sig. (bilateral)		0,001
		N	80	80
	CORRECTIVE MAINTENANCE	Correlation coefficient	0.376**	1.000
		Sig. (bilateral)	0,001	
		N	80	80

\*\* The correlation is significant at level 0.01 (2 tails).

Importance and correlation between administrative control and preventive maintenance of the company Cala pavimentos y construcciones EIRL.

From table 5: it is observed that the value of  $p = 0.001$  therefore the null hypothesis is rejected and the alternative hypothesis is accepted (hypothesis of

the researcher), that is, there is a relationship between maintenance control and preventive maintenance of the company cala pavements and constructions EIRL – San Juan de Miraflores 2017; And given the value of the correlation coefficient rho sperman = 0.356 according to the bisquerra scale, this correlation is victim

Table 5, significance and correlation between administrative control and preventive maintenance of the company cala pavements and constructions EIRL

			ADMINISTRATIVE CONTROL	PREVENTIVE MAINTENANCE
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.356**
		Sig. (bilateral)		0,001
		N	80	80
	PREVENTIVE MAINTENANCE	Correlation coefficient	0.356**	1.000
		Sig. (bilateral)	0,001	
		N	80	80

\*\* The correlation is significant at level 0.01 (2 tails).

Significance and correlation between the administrative control and maintenance of opportunity of the company Cala pavimentos and EIRL constructions.

From table 6: it is observed that the value of  $p = 0.000$  therefore the null hypothesis is rejected and the alternative hypothesis is accepted (hypothesis of

the researcher), that is, there is a relationship between the maintenance control and the maintenance opportunity of the company cala pavimentos y construcciones EIRL – San Juan de Miraflores 2017; and given the value of the correlation coefficient rho sperman = 0.474 according to the bisquerra scale, This correlation is moderate.

Table 6 Significance and correlation between administrative control and maintenance of opportunity of the company cala pavements and constructions EIRL.

			ADMINISTRATIVE CONTROL	MAINTENANCE OF OPPORTUNITY
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.474**
		Sig. (bilateral)		0.000
		N	80	80
	MAINTAINING THE OPPORTUNITY	Correlation coefficient	0.474**	1.000
		Sig. (bilateral)	0.000	
		N	80	80

\*\* The correlation is significant at level 0.01 (2 tails).

Importance and correlation between administrative control and fault detection of the company Cala pavimentos y construcciones EIRL.

From Table 7: it is observed that the value of  $p = 0.003$  therefore the null hypothesis is rejected and the alternative hypothesis is accepted (hypothesis of

the researcher), that is, there is a relationship between the maintenance control and the detection of failures of the company cala pavimentos y construcciones EIRL – San Juan de Miraflores 2017; and given the value of the rho sperman correlation coefficient = 0.327 according to the Bisquerra scale, This correlation is low.

Table 7 Significance and correlation between administrative control and fault detection of company cove pavements and EIRL constructions.

			ADMINISTRATIVE CONTROL	FAULT DETECTION
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.327**
		Sig. (bilateral)		0,003
		N	80	80
	FAULT DETECTION	Correlation coefficient	0.327**	1.000
		Sig. (bilateral)	0,003	
		N	80	80

Significance and correlation between the administrative control and the modification of the design of the company Cala pavimentos y construcciones EIRL.

From Table 8: it is observed that the value of  $p = 0.000$  therefore the null hypothesis is rejected and the alternative hypothesis is accepted (hypothesis of the researcher), that is, there is a relationship

between the maintenance control and the modification of the design of the company cala pavimentos y construcciones EIRL – San Juan de Miraflores 2017; and given the value of the correlation coefficient Rho sperman = 0.838 according to the Bisquerra scale, This correlation is high

Table 8 Significance and correlation between the administrative control and the modification of the design of the pavements and cove constructions of the EIRL company.

			ADMINISTRATIVE CONTROL	DESIGN MODIFICATION
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.838**
		Sig. (bilateral)		0.000
		N	80	80
	DESIGN MODIFICATION	Correlation coefficient	0.838**	1.000
		Sig. (bilateral)	0.000	
		N	80	80

Significance and correlation between the administrative control and the general repair of the company Cala pavimentos y construcciones EIRL. From Table 9: it is observed that the value of  $p = 0.000$  therefore the null hypothesis is rejected and the alternative hypothesis (hypothesis of the

researcher) is accepted, that is, there is a relationship between the maintenance control and the modification of the design of the company cala pavimentos y construcciones EIRL – San Juan de Miraflores 2017; And given the value of the rho spearman correlation coefficient = 0.634 according to the Bisquerra scale, this correlation is moderate.

Table 9 Significance and correlation between administrative control and general repair of the company's cove pavements and EIRL constructions.

			ADMINISTRATIVE CONTROL	GENERAL REPAIR
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	,634**
		Sig. (bilateral)		.000
		N	80	80
	GENERAL REPAIR	Correlation coefficient	,634**	1.000
		Sig. (bilateral)	.000	
		N	80	80

\*\* The correlation is significant at level 0.01 (2 tails).

Significance and correlation between administrative control and the replacement of the company Cala pavimentos y construcciones EIRL.

From table 10: it is observed that the value of  $p = 0.000$  therefore the null hypothesis is rejected and

the alternative hypothesis is accepted (hypothesis of the researcher), that is, there is a relationship between the maintenance control and the modification of the design of the company cala pavimentos y construcciones EIRL – San Juan de Miraflores 2017; and given the value of the rho

spearman correlation coefficient = 0.529 according to the bisquerra scale said correlation is moderate.

Table 10 Significance and correlation between administrative control and replacement of EIRL pavements and cove constructions

			ADMINISTRATIVE CONTROL	REPLACEMENT
Spearman's Rho	ADMINISTRATIVE CONTROL	Correlation coefficient	1.000	0.529**
		Sig. (bilateral)		0.000
		N	80	80
	REPLACEMENT	Correlation coefficient	0.529**	1.000
		Sig. (bilateral)	0.000	
		N	80	80

#### 4. Discussion

Many studies have investigated administrative control and pavement repair, but few have introduced a method for incorporating pavement management into the PMS [14, 15, 16]. This research presents a framework for pavement management and administrative control by incorporating an analysis from a case study firm's perception into an existing framework for uncertain decision-making [17, 18]. The approach was demonstrated at a coastal road pavement assessment site, but can be extended to inland road infrastructure when planning for climate change. The approach is also suitable for incorporation into PMS [19].

The approach includes analysis based on scenarios and assets and it was shown that 37.5% of Administrative Control, 33.8% maintenance and yet 28.7% have no knowledge depending on the detail of each of the variables, it is important to highlight that the degree of correlation was 0.996 and a significance value less than 0.01; Therefore it must be said that if there is a relationship between both variables. These findings are similar to those found by Alharbi et al., [20]. since in his study on the improvement of maintenance management that resulted in the average accuracy of knowledge was 35% in similarity that gave importance to maintenance generating the process to improve it in the present study.

In the studies we rescue both the importance of complying with the degrees of good maintenance of the machinery to be used and the influence of knowing the processes to be carried out and how this relates to the other processes of the company, this

being one of the most important in the production of the company. In the case of Tutu and Yar [21] who studied administrative control and generated processes for better business and economic development, leaving the new administrator to make the corresponding evaluation of this pilot project, generating 83% reliability, so it is essential that there is good administrative control within a company. Bebbarma, Solomon and Ransinchung, [22] in their study on administrative control concludes that the profitability of a company depends on good administrative management and its financial situation, applied the profitability indices where it determined that there is instability in past years that was not organized and that the lack of control causes a minimum profit margin, ending with this sentence, Administrative control affects the profitability of the company and according to the dispersion curve obtained 2,087. According to Gu et al., [23] studied the structural performance and sustainability assessment of the cold central plant and on-site recycled asphalt pavements: a case study. They consider criteria of mechanical performance, environmental impact and economic benefit to introduce sustainable asphalt mixtures with high content of regenerated asphalt pavements. Low temperature cracking, moisture susceptibility, fatigue cracking, and resistance to groove formation of asphalt concrete [24].

#### 5. Conclusions

It has been shown that there is a direct relationship between the Administrative Control and the Corrective Maintenance of the company Cala Pavimentos y Construcciones EIRL – san juan de



Miraflores 2017 obtaining a ratio of Spearman's Rho = 0.376, indicating that there is a relationship with a low level of correlation, likewise a significance level of  $p = 0.000 < 0.01$  was obtained, which allows to demonstrate that the relationship is significant. Likewise, there is a direct relationship between the Administrative Control and the preventive maintenance of the company Cala Pavimentos y Construcciones EIRL – San Juan de Miraflores 2017, obtaining a ratio of Spearman's Rho = 0.356, indicating that there is a relationship with a high level of correlation, therefore a significance level of  $p = 0.000 < 0.01$  was obtained. There is a direct relationship between the Administrative Control and the maintenance of opportunity of the company Cala Pavimentos y Construcciones EIRL – San Juan de Miraflores 2017 obtaining a relationship of Spearman's Rho = 0.474 indicating that there is a relationship with a moderate correlation level, likewise a significance level of  $p = 0.000 < 0.01$  was obtained, which allows to demonstrate that the relationship is significant. It was demonstrated that there is a direct relationship between the Administrative Control and the detection of failures of the company Cala Pavimentos y Construcciones EIRL – San Juan de Miraflores 2017 obtaining a ratio of Spearman's Rho = 0.327, indicating that there is a relationship with a high level of correlation, so a significance level of  $p = 0.003 < 0.01$  was obtained, which allows to demonstrate that the relationship is significant.

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