Lessons learned from GSR projects in the colombian Pacific Region

Lecciones aprendidas de proyectos del SGR en la Región Pacífica colombiana

Lições aprendidas com projetos de ferrovias de bitola estreita na região do Pacífico colombiano

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Abstract

Introduction: Formulation of best practices for the execution of projects funded by the General Royalties System (SGR) in Colombia's Pacific Region (2012–2022), conducted at Pontificia Universidad Javeriana Cali in 2023.

Problem: The SGR has funded over 24,000 projects in the Pacific Region of Colombia, but improvements in quality of life have been limited. This situation is exacerbated by structural issues such as corruption, insecurity, and deficiencies in project management.

Objective: The study identifies and systematizes best practices in SGR-funded projects, analyzing both successful and critical cases (2012–2022).

Methodology: A total of 3,864 SGR projects (2012–2022) were analyzed. A representative sample of fully completed projects was selected, and performance indicators and risk management practices were systematically assessed using data from multiple sources.

Results: Successful projects were characterized by efficient planning, risk management, and continuous supervision. In contrast, underperforming projects faced recurrent issues in planning, corruption, and low citizen participation.

Conclusion: Context-specific risk management, combined with realistic and participatory planning, significantly enhances the efficiency of public investment and its impact on communities.

Originality: This research fills a gap in the literature on territorial public management by offering a typology of evidence-based good practices from a historically disadvantaged region.

Limitations: Findings are limited to the Pacific Region and projects with complete data, requiring additional studies for broader generalization.

Keywords: Public investment, Project evaluation, Risk, Public administration, Regional development.

Resumen

Introducción: Formulación de buenas prácticas durante la ejecución de proyectos financiados por el Sistema General de Regalías (SGR) en la Región Pacífica (2012–2022), desarrollado en la Pontificia Universidad Javeriana Cali en 2023.

Problema: El SGR ha financiado más de 24.000 proyectos en la Región Pacífica de Colombia, pero los beneficios en calidad de vida han sido limitados. Esta situación se agrava por problemas estructurales como la corrupción, la inseguridad y las deficiencias en la gestión de los proyectos.

Objetivo: El estudio identifica y sistematiza buenas prácticas en proyectos financiados por el SGR, analizando tanto los exitosos como los críticos (2012–2022).

Metodología: Se analizaron 3.864 proyectos del SGR (2012–2022). Se seleccionó una muestra representativa de proyectos terminados con ejecución total, y se evaluaron indicadores de desempeño y prácticas de gestión de riesgos a partir de diversas fuentes de datos.

Resultados: Los proyectos exitosos destacaron por una planeación eficiente, una gestión de riesgos adecuada y una supervisión continua. En contraste, los de bajo desempeño presentaron deficiencias en planeación, corrupción y baja participación ciudadana.

Conclusión: Una gestión contextualizada del riesgo, combinada con una planeación realista y participativa, mejora significativamente la eficiencia de la inversión pública y su impacto en las comunidades.

Originalidad: El estudio contribuye a llenar un vacío en la literatura sobre gestión pública territorial, al ofrecer una tipología de buenas prácticas basada en evidencia empírica del SGR en una región históricamente rezagada.

Limitaciones: Los hallazgos se limitan a la Región Pacífica y a proyectos con información completa, lo que requiere estudios adicionales para su generalización.

Palabras clave: Inversión pública, Evaluación de proyectos, Riesgo, Administración pública, Desarrollo regional.

Resumo

Introdução: Formulação de melhores práticas durante a execução de projetos financiados pelo Sistema Geral de Royalties (SGR) na Região do Pacífico (2012–2022), desenvolvida na Pontifícia Universidade Javeriana de Cali em 2023.

Problema: O SGR financiou mais de 24.000 projetos na Região do Pacífico da Colômbia, mas os benefícios em termos de qualidade de vida têm sido limitados. Essa situação é agravada por problemas estruturais como corrupção, insegurança e deficiências na gestão de projetos.

Objetivo: O estudo identifica e sistematiza as melhores práticas em projetos financiados pelo SGR, analisando tanto projetos bem-sucedidos quanto projetos críticos (2012–2022).

Metodologia: Foram analisados 3.864 projetos do SGR (2012–2022). Uma amostra representativa de projetos concluídos foi selecionada, e indicadores de desempenho e práticas de gestão de riscos foram avaliados utilizando diversas fontes de dados.

Resultados: Os projetos bem-sucedidos se destacaram pelo planejamento eficiente, gestão de riscos adequada e monitoramento contínuo. Em contraste, os projetos de baixo desempenho apresentaram deficiências no planejamento, corrupção e baixa participação cidadã.

Conclusão: A gestão de riscos contextualizada, combinada com um planejamento realista e participativo, melhora significativamente a eficiência do investimento público e seu impacto nas comunidades.

Originalidade: Este estudo contribui para preencher uma lacuna na literatura sobre gestão pública territorial, oferecendo uma tipologia de boas práticas baseada em evidências empíricas do Sistema Geral de Royalties (SGR) em uma região historicamente desfavorecida.

Limitações: As conclusões se limitam à Região do Pacífico e a projetos com informações completas, sendo necessários estudos adicionais para generalização.

Palavras-chave: Investimento público, Avaliação de projetos, Risco, Administração pública, Desenvolvimento regional.

I. INTRODUCTION

Royalties represent a critical source of income for countries engaged in the extraction of non-renewable natural resources, as they constitute the primary sectoral tax associated with this economic activity [1]–[6]. Despite their fiscal significance [7], limited scholarly attention has been devoted to analyzing the heterogeneous regional impacts of these revenues [8]. The institutional framework governing their allocation determines the share allocated to subnational entities and aims to fund investment projects designed to mitigate socioeconomic and infrastructural disparities [9]–[12].

However, ineffective project execution may lead to inefficiencies or even institutional crises [13].

In the Colombian context, the General System of Royalties (Sistema General de Regalías, SGR)—established through Legislative Act 05 of 2011 and initially regulated by Law 1530 of 2012 (later amended by Law 2056 of 2020)—centralizes mining and energy revenues for equitable territorial distribution. This system operates via the Collegiate Administration and Decision-Making Body (Órgano Colegiado de Administración y Decisión, OCAD), composed of representatives from national, departmental, and municipal governments [10], [14], [15] (see Figure 1).

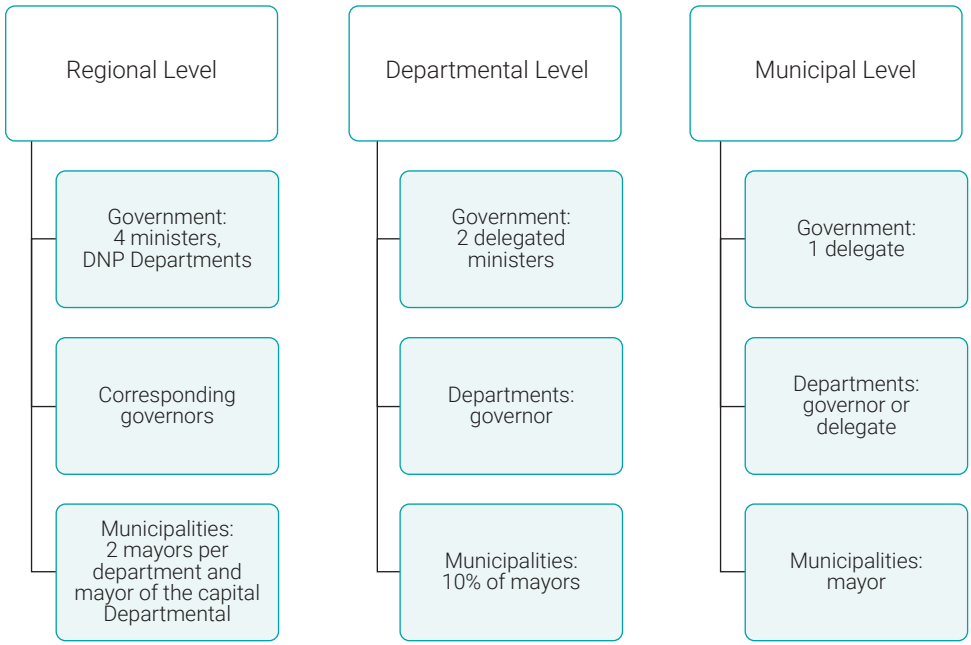

Figure 1. Collegiate Administration and Decision-Making Body (OCAD)
Source: Authors

Despite this institutional framework, the Colombian Pacific Region—comprising the departments of Cauca, Nariño, Valle del Cauca, and Chocó—continues to face structural challenges in the execution of GSR-funded projects. Cases of unfinished or non-functional infrastructure, documented instances of corruption, and poor administrative performance [16], [17] underscore systemic weaknesses in the planning, monitoring, and completion of public projects.

This study presents a systematic compilation of best practices in the administration of projects financed through the General Royalties System. The analysis employs

a comparative framework, examining both high-performance emblematic projects and critically challenged initiatives implemented in Colombia's Pacific Region during the 2012–2021 period. For the purposes of this investigation, projects are classified as emblematic when satisfying the following quantitative and qualitative parameters:

- Completion status: Full physical implementation (100% work completion) and comprehensive financial execution (100% budget utilization).
- Performance metrics: Cost Performance Index (CPI) = 1.0, Schedule Performance Index (SPI) = 1.0, Schedule Variance (SV(t)) = 0.0.
- Planning accuracy: Demonstrated adherence to established timelines, compliance with approved budgetary constraints, and documented planning reliability throughout the project lifecycle.

1.1 Physiographic Organization of Colombia

Colombia exhibits remarkable geographic diversity [18], characterized by its dual-ocean access (Pacific and Atlantic) [19], and abundant natural resources, including exceptional biodiversity, mineral deposits, and petroleum reserves [20]. The nation's legal framework has evolved through constitutional reforms, beginning with the 1886 Constitution and substantially modified by the 1991 Constitution [1].

The country comprises six distinct natural regions: Pacific, Caribbean, Llanos (Orinoquía), Amazon, Andes [19], and Insular. The Pacific Region—the focus of this investigation—is particularly noteworthy for two key characteristics: it contains one of the world's most biodiverse coastal ecosystems [19], boasting the greatest concentration of floral wealth in the planet's humid terrestrial biomes [19]. Within the General System of Royalties (GSR) framework, this region ranks fourth in both allocated and executed funds, with budgeted and actual expenditures of COP 149.7 trillion and COP 89.7 trillion, respectively [21].

Regional investment patterns reveal significant disparities:

- Pacific Region: Budgeted COP 149.7 trillion (executed COP 89.7 trillion; 14.43% of national total).
- Caribbean Region: Budgeted COP 216.7 trillion (executed COP 140.6 trillion; 20.89%).
- Coffee Axis Region: Budgeted COP 170.2 trillion (executed COP 99.9 trillion; 16.41%).

- Central-Eastern Region: Budgeted COP 309 trillion (executed COP 167.3 trillion; 29.79%).
- Llanos Region: Budgeted COP 78.7 trillion (executed COP 47.5 trillion; 7.59%).
- South-Central Region: Budgeted COP 113.1 trillion (executed COP 52.2 trillion; 10.90%).

These expenditure patterns demonstrate substantial variation in budget execution efficiency across regions. Current conditions in the Pacific Region reveal systemic challenges in GSR resource management, particularly through incomplete or non-functional infrastructure projects [16]. This evidence underscores the urgent need to establish best practices aligned with the triple-constraint effectiveness metric (scope–time–cost compliance).

1.2 Challenges of the GSR in the Pacific Region

The General System of Royalties (GSR) serves as a critical mechanism for financing public investment projects in Colombia. Nevertheless, despite the approval of 24,915 projects in the Pacific Region over the past decade, minimal improvements have been observed in key quality-of-life indicators—including healthcare, education, housing, public services, and income levels—for target populations [17]. This trend persists across multiple Colombian municipalities [22], where persistent gaps in basic living conditions have contributed to a measurable decline in residents' well-being, further aggravated by regional insecurity.

These conditions adversely affect project implementation efficiency, introducing substantial risks and barriers to achieving intended outcomes. Compounding these challenges are pervasive governance issues, particularly corruption, which distorts both resource allocation and execution processes.

2. METHODOLOGY

This research adopted a quantitative-descriptive design enhanced by comparative analysis. Primary data were extracted from the General System of Royalties (GSR) Information System [23], encompassing all projects approved between 2012 and 2021 in the Pacific Region departments of Cauca, Nariño, Valle del Cauca, and Chocó. The dataset, obtained from Colombia's National Planning Department (DNP), included the following variables for each project: project identification (name), approved

budget allocation, current implementation status, execution timeline, physical completion percentage, financial execution percentage, and performance metrics (SPI, CPI, SV(t)).

2.1 Study Sample Selection

A total of 3,864 projects from 2012 to 2022 were retrieved from the GSR information system (https://www.sgr.gov.co/Vigilancia/ResultadoseInformes.asp), distributed as follows: Nariño, 1,594 projects (41.3% of total); Cauca, 925 projects (23.9%); Valle del Cauca, 741 projects (19.2%); Chocó, 604 projects (15.6%).

The final sample was derived through a two-stage selection process:

- Status filtering: Initial selection of completed projects only.
- Statistical sampling: Application of Equation 1 [17] to determine representative sample size.

Ecuación 1

$$\text{n(finito)}=\frac{(Z^2)x\ (N*0.9*0.1)}{E^2x\ N-1)+(Z^2x\ 0.9\ x\ 0.1)}$$

Where:

n: Sample size
Z: Z-score (confidence level)
0.9: Margin of error
0.1: Difference from 100%
E: Precision, determined by study conditions
N: Population/unit/service

ChatGPT said:

2.2 Completed Projects Within the Study Scope

A comprehensive analysis was conducted on a dataset containing information from 3,864 projects, including project name, approved budget, approval date, current status, physical and financial progress percentages, and performance indicators (SPI, CPI, SV(t)). Projects classified as "closed," "completed," or "pending closure" were evaluated to assess their completion status and efficiency.

Projects meeting 100% physical and financial completion were filtered for further evaluation of their scope adherence and cost efficiency. Key aspects examined included the year with the highest project efficiency and the prevailing regulatory framework during peak performance.

Projects were classified as emblematic based on fulfillment of the following criteria:

- Full completion: 100% physical and financial execution.
- Performance metrics:
  - Schedule Performance Index (SPI) = 1.0.
  - Cost Performance Index (CPI) = 1.0.
  - Schedule Variance (SV(t)) = 0.0.
- Resource allocation aligned with the approved scope.
- Timeline adherence to the originally proposed schedule.

2.3 Analysis of Project Performance Indicators

A subset of ongoing projects was selected for further analysis, collecting additional data such as implementation period, planned vs. actual costs, SPI, CPI, and SV(t) to assess performance. The objective was to identify the most influential variables and derive good practices and risk management lessons. The goal was to support evidence-based decision-making and avoid future project inefficiencies.

2.4 Lessons Learned

A detailed analysis of high-performance projects (in terms of scope, time, and cost) was conducted. Lessons learned and good practices were compiled through field visits and expert consultation in collaboration with the DNP and local stakeholders. Findings reflect empirical insights from the implementation of GSR-funded projects in the Pacific Region.

3. RESULTS

3.1 Identification of Completed Projects

This section presents the identification and evaluation of completed projects by departments, their performance against defined indicators, and the overall comparative

trends across the region. Projects were assessed to determine the level of compliance with the CPI, SPI, and SV(t) metrics, and to extract quantitative patterns and managerial implications.

3.1.1 Department of Cauca

The Department of Cauca ranked second in the Pacific Region in terms of executed resources from the General System of Royalties (GSR), with a total of 925 projects identified. Of these, 578 were finalized, and 351 met the specific research criteria. For this evaluation, planned completion dates, actual completion dates, and time overruns in months (SV(t)) were considered.

Table 1. Completed projects by year in the Department of Cauca

Year	A	B	C	D	E	F	G
2012	23	16	1	15		70%	0
2013	168	148	18	126	4	88%	10
2014	81	77	4	72	1	95%	3
2015	116	101	15	85	1	87%	0
2016	15	12		12		80%	10
2017	85	64	8	55	1	75%	14
2018	102	67	20	46	1	66%	14
2019	151	62	20	40	2	41%	15
2020	61	26	3	22	1	43%	8
2021	62	5	1	4		2%	0
2022	61	0				0%	0
TOTAL	925	578	90	477	11	62,49%	351

Note: A = Total number of projects; B = "Completed" projects; C = Status: Completed; D = Status: Closed; E = Status: Pending closure; F = Completion percentage; G = Projects fully meeting scope, time, and cost criteria

Source: Compiled with data from [17] using the GESPROY-SGR platform from DNP

The results show that 2019 had relatively stronger execution in Cauca, with 151 approved projects only 41% (62 projects) were completed. Furthermore, only 24% of those completed projects achieved 100% physical and financial progress without delays (i.e., SV(t) = 0). In 2012, 2015, and 2021, no projects met the full compliance criteria defined for this study.

3.1.2 Department of Nariño

The analysis of completed projects in the Department of Nariño shows a total of 1,594 approved projects, of which 1,127 were completed, and 181 met the criteria of interest for this study (Table 2).

Table 2. Completed projects by year in the Department of Nariño

Year	A	B	C	D	E	F	G
2012	99	88	19	66	3	89%	5
2013	273	230	45	174	11	84%	19
2014	217	195	21	171	3	90%	6
2015	148	133	25	105	3	90%	15
2016	19	19		17	2	100%	2
2017	111	86	18	64	4	77%	13
2018	140	116	32	77	7	83%	27
2019	227	156	60	90	6	69%	45
2020	86	46	15	24	7	53%	22
2021	115	49	35	9	5	43%	25
2022	159	9	7	1	1	6%	2
TOTAL	1594	1127	277	798	52	70,70%	181

Note: A = Total number of projects; B = "Completed" projects; C = Status: Completed; D = Status: Closed; E = Status: Pending closure; F = Completion percentage; G = Projects fully meeting scope, time, and cost criteria

Source: Compiled with data from [17] using the GESPROY-SGR platform from DNP

Of the 1,127 completed projects, 728 reached 100% in both physical and financial progress. Notably, the year 2013 stood out for high compliance in terms of scope and cost, with 230 completed projects, 138 of which met all criteria.

In particular, the year 2019 showed improvement in executing projects under the triple constraint (scope, time, and cost). Of the 156 completed projects that year, 28.85% fully complied with these parameters.

In summary, only 16.06% of completed projects fully met the scope, time, and cost criteria as defined in their formulation and approval processes—equivalent to 181 projects. This reflects a significant level of noncompliance with projected timelines.

3.1.3 Department of Valle del Cauca

As shown in Table 3, the year 2019 recorded the highest number of projects both approved and completed in full compliance with the triple constraint of scope, time,

and cost. A total of 118 projects were completed, of which only 33.90% fully met these requirements, according to data from the GESPROY platform under the execution tab.

Conversely, during the years 2012, 2014, 2015, and 2016, a lower proportion of projects met the established study criteria. In 2012, nine projects were approved and all were completed. In 2014, 73 projects were approved, of which 63 were finalized. In 2015, 86 projects were approved and 81 completed. In 2016, 29 projects were approved and 26 completed, based on information obtained from [23].

In summary, from 2012 to 2022, a total of 741 projects were approved in Valle del Cauca, of which 560 (75.75%) were completed. However, only 17.32% of the completed projects (97 in total) fully met the scope, time, and cost criteria as set out during formulation and approval. Overall, a similar pattern is observed in the departments of Cauca, Nariño, and Valle del Cauca.

Table 3. Completed projects by year in the Department of Valle

Year	A	B	C	D	E	F	G
2012	9	9	0	9	0	100%	1
2013	84	84	5	79	0	100%	9
2014	73	63	9	54	0	86%	4
2015	86	81	2	79	0	94%	3
2016	29	26	1	25	0	90%	2
2017	87	73	6	66	1	84%	8
2018	81	68	6	61	1	84%	13
2019	156	118	16	98	4	76%	40
2020	54	27	2	24	1	50%	13
2021	36	11	4	6	1	31%	4
2022	46	0	0	0	0	0%	0
TOTAL	741	560	51	501	8	75,57%	97

Note: A = Total number of projects; B = "Completed" projects; C = Status: Completed; D = Status: Closed; E = Status: Pending closure; F = Completion percentage; G = Projects fully meeting scope, time, and cost criteria

Source: Compiled with data from [17] using the GESPROY-SGR platform from DNP

3.1.4 Department of Chocó

The economic and social situation in Chocó has seen little structural improvement in recent years. Although some progress has been made, the gap between Chocó and the rest of the country persists [14]. The local population continues to demand

increased coverage of public services, education, housing, and other unmet basic needs [14].

It is important to note that, in addition to the General System of Participations and the GSR, municipalities also receive funding through tax and non-tax revenues, which increases their total income [14]. This department shows a high GINI coefficient, confirming a significant income disparity compared to mining departments [24].

As in the departments of Cauca, Nariño, and Valle del Cauca, 2019 was the year with the highest number of approved projects in Chocó (Table 4), with 98 approved and 76 successfully completed.

Table 4. Completed projects by year in the Department of Chocó

Year	A	B	C	D	E	F	G
2012	20	19	4	15	0	95%	2
2013	87	71	15	55	1	82%	3
2014	47	41	10	31	0	87%	6
2015	58	49	9	40	0	84%	8
2016	7	6	2	4	0	86%	0
2017	69	62	13	47	2	90%	15
2018	59	52	29	22	1	88%	16
2019	98	76	30	43	3	78%	34
2020	49	24	11	11	2	49%	15
2021	55	19	12	6	1	35%	9
2022	55	3	3	0	0	5%	0
TOTAL	604	422	138	274	10	70,78%	108

Note: A = Total number of projects; B = "Completed" projects; C = Status: Completed; D = Status: Closed; E = Status: Pending closure; F = Completion percentage; G = Projects fully meeting scope, time, and cost criteria

Source: Compiled with data from [17] using the GESPROY-SGR platform from DNP

3.1.5 Relevant Findings

Figure 2 illustrates the level of compliance with the scope, time, and cost indicators in the four departments of the Pacific Region: Nariño, Cauca, Valle del Cauca, and Chocó. It is important to note that the sum of the percentages does not total 100% because each indicator's compliance is presented as a percentage relative to the total number of completed projects in each department. The purpose of this analysis is to

identify which indicators exhibit the highest and lowest levels of compliance in projects funded through the General System of Royalties (GSR).

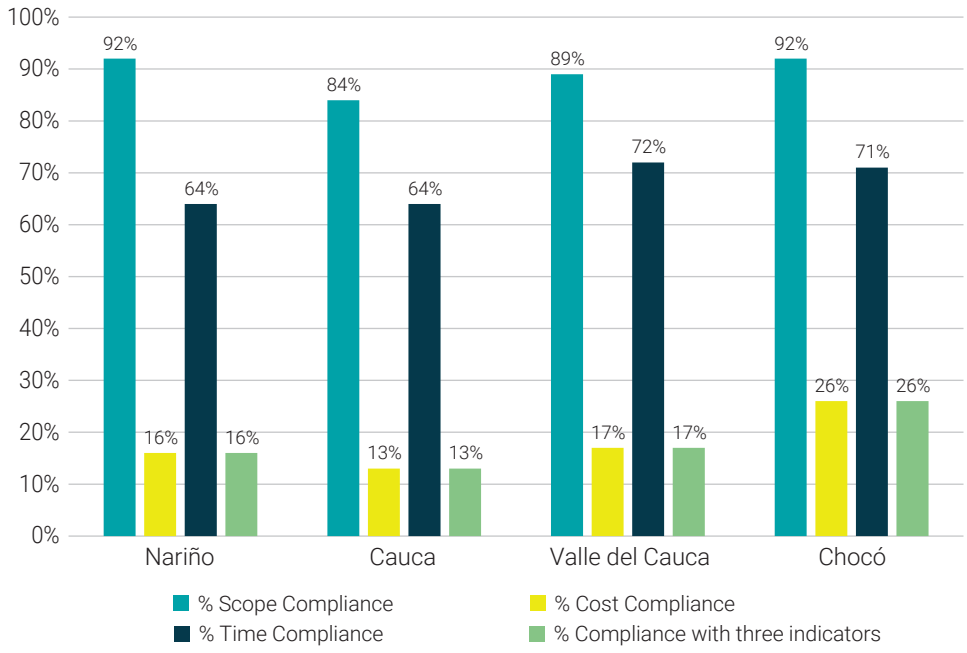

Figure 2. Percentage of compliance with scope, time, and cost in the projects
Source: Prepared with data from [17]

In the Department of Nariño, 70.70% of the approved projects have been completed. Of these, 1,038 comply with the scope indicator, 710 with the cost indicator, and 181 with the time indicator. Consequently, scope shows the highest degree of compliance, followed by cost, with a 28% gap between the two. Conversely, time is the indicator with the lowest compliance rate in this department, highlighting a significant constraint in the formulation and approval of projects.

Similarly, in the Department of Cauca, Figure 2 shows that 62.49% of the approved projects have been completed. Specifically, 488 projects comply with the scope indicator, 369 with cost, and only 74 with time. As in Nariño, scope is the most fulfilled indicator, followed by cost, with time showing the least compliance.

In the Department of Valle del Cauca, Figure 2 indicates that 75.75% of the approved projects have been completed, totaling 560 projects. Of these, 89% (497 projects) fully meet the scope indicator, 72% (401 projects) the cost indicator, and only 17% (97 projects) the time indicator. As in previous cases, scope has the highest compliance, followed by cost, while time remains the greatest challenge in the execution of GSR-funded projects.

Lastly, in the Department of Chocó, Figure 2 shows that 69.87% of the approved projects have been completed, equivalent to 422 projects. Of these, 92% (389 projects) comply with scope, 71% (298 projects) with cost, and only 26% (108 projects) with time. As in the other departments, scope shows the highest compliance, followed by cost, while time continues to be the most difficult indicator in project implementation under the GSR.

3.2 Findings on Scope, Cost, and Time Indicators

For the analysis of the results, percentages of compliance by department were compared instead of absolute numbers of completed projects. This approach facilitates the identification of departments with superior performance in project execution and helps extract best practices.

Regarding scope compliance, the Department of Nariño achieved the highest percentage, at 92%, followed closely by Chocó with 92%, Valle del Cauca with 89%, and Cauca with 84%.

For cost compliance, projects in Valle del Cauca lead with 72%, followed by Chocó with 71%, while both Nariño and Cauca show 64% compliance.

Concerning time compliance, Chocó again ranks highest with 26%, followed by Valle del Cauca (17%), Nariño (16%), and Cauca (13%).

Overall, the time indicator represents the most significant constraint across all indicators. Cauca shows the lowest percentage of compliance in all three indicators. In contrast, Chocó excels in time and scope and comes close to the top performer in cost.

It is noteworthy that despite receiving fewer resources and executing fewer projects than other departments, Chocó has achieved more favorable results in scope and time, and comparable outcomes in cost. These results are particularly significant given the challenges the department faces, including public order issues and adverse climate conditions. These findings offer valuable insights into best practices for executing GSR-funded projects.

3.3 Performance Indicator Comparison

To compare performance indicators, projects that achieved 100% physical and financial progress and met all requirements were selected—specifically, those with a Schedule Performance Index (SPI) and Cost Performance Index (CPI) of 1.0, and a Schedule Variance (SV(t)) of 0.0, indicating no delays.

The SPI measures how closely a project follows its original schedule. A value of 1.0 indicates the project is precisely on track. Values above 1.0 suggest the project is ahead of schedule, while values below 1.0 indicate delays.

The CPI evaluates financial performance. A CPI of 1.0 means the project is on budget. Values above 1.0 imply cost savings, while values below 1.0 indicate budget overruns.

Table 5 provides the ranges considered by the DNP for the compliance indicators in programming and cost.

Table 5. SPI and CPI calculation and analysis

Indicator	Calculation and análisis verification	
	Estimation	**Rating/level**
SPI (Schedule Compliance)	Earned Value (EV) / Planned Value (PV)	High: 1.1–0.85Medium: 0.85–0.70Low: 0.70–0.40Insufficient: <0.40
CPI (Cost Compliance)	Earned Value / Actual Cost (AC)	High: 1.1–0.85Medium: 0.85–0.70Low: 0.70–0.40Insufficient: <0.40

Source: Taken from the Investment Monitoring Manual [23]

The departmental performance analysis shows the following issues:

- Nariño: Of 1,594 approved projects, 1,127 were completed. Only 15 fully met the earned value indices, reflecting low performance.
- Valle del Cauca: Of 741 approved projects, 560 were completed, and only 15 fully complied with earned value indices.
- Cauca: Of 925 approved projects, 578 were completed. Only 11 fully met the earned value criteria.
- Chocó: Of 604 approved projects, 422 were completed, with 22 fully complying with earned value metrics.

3.3.1 Schedule compliance analysis in the Pacific Region:

SPI was calculated as Earned Value (EV) / Planned Value (PV). To determine the compliance percentage, the number of projects with SPI = 1.0 was divided by the total number of completed projects. Table 6 details each department's performance.

Table 6. Schedule compliance (SPI) in the Pacific Region Departments

Department	Approved projects	Completed projects	SPI=1	Compliance (%)
Cauca	925	578	106	18%
Nariño	1594	1127	257	23%
Valle del Cauca	741	560	90	16%
Chocó	604	422	139	33%

Source: Prepared with data from [17]

The analysis reveals that the Department of Chocó has achieved the highest level of compliance in terms of programming, with 139 projects executed on schedule, representing 33% of completed projects. Next in line is the Department of Nariño, with 257 completed projects, equivalent to 23%. The Department of Cauca ranks third with 106 completed projects, representing 18%, followed by the Department of Valle del Cauca, with 90 completed projects, equivalent to 16%.

Although the total number of projects that achieved this level of compliance is relatively low, representing less than 50% of completed projects, the results demonstrate that high compliance is possible. This finding underscores the importance of leadership and effective management in project planning and monitoring.

Successful examples in departments with high compliance can serve as a model and inspiration for future projects. The results obtained highlight the need for rigorous planning, continuous monitoring, and agile and efficient decision-making. Furthermore, these results invite departments with lower compliance to investigate the causes of deviations and implement corrective measures to improve their performance in terms of programming.

3.3.2 Cost Compliance Analysis by Department

For this analysis, the formula Earned Value (EV) divided by Actual Cost (AC) was used, yielding an index of 1.0. This indicator reflects the degree of cost compliance for each project evaluated (Table 7).

Table 7. Cost compliance (CPI) in the Pacific Region

Department	Approved projects	Completed projects	CPUI=1	Compliance %
Cauca	925	578	144	25%
Nariño	1594	1127	346	31%
Valle del Cauca	741	560	138	25%
Chocó	604	422	163	39%

Source: Prepared with data from [17]

Table 7 provides a detailed overview that allows us to identify the departments with the highest number of projects strictly complying with established costs.

An examination of the data reveals that the Department of Chocó leads with the greatest number of projects that have fully met their costs, reaching a total of 163 projects, equivalent to 39% of completed projects. The Department of Nariño follows with 346 projects, representing 31%. The Department of Cauca ranks third with 144 projects, corresponding to 25%, and the Department of Valle del Cauca records 138 projects, also representing 25%. It is relevant to note that the departments' ranking in terms of cost compliance coincides with the ranking observed in the previous analysis on schedule compliance.

These results suggest that the departments have demonstrated greater capacity to meet costs compared to schedules, reflecting more effective management in controlling the costs of funded projects. They have managed to stay within the budget limits established during project formulation, which is crucial to ensure efficient use of resources and achieve the stated objectives.

3.3.3 Variation of Time Analysis by Department

For this analysis, projects that obtained a score of zero on the SV(t) indicator were considered. This indicator is calculated using the formula: Earned Schedule (ES) minus Actual Project Duration at the Control Date (AT).

Table 8 presents the results of the time variation (SV(t)) for projects in the four departments of the Pacific Region. It is observed that this indicator shows higher results than the schedule on-time indicator. Furthermore, the ranking of the departments with the best performance on SV(t) coincides with the ranking observed for the schedule on-time and cost on-time indicators.

Table 8. Time variation SV(t) in the Pacific Region

Department	Approved projects	Completed projects	SV(t)=0	Compliance %
Cauca	925	578	140	24%
Nariño	1594	1127	326	29%
Valle del Cauca	741	560	107	19%
Chocó	604	422	159	38%

Source: Prepared with information from [17]

ChatGPT said:

First, it is observed that projects in the Department of Chocó show the lowest variation over time. A total of 159 projects were identified with an SV(t) equal to zero, representing 38% of the total projects completed in this department. Next comes the Department of Nariño, with 326 projects, equivalent to 29% of the total. The Department of Cauca follows with 140 projects, corresponding to 24% of the total, while the Department of Valle del Cauca reports 107 projects, representing 19% of the total completed projects.

These results indicate that the Department of Chocó has achieved outstanding performance in terms of deadline compliance, followed by the departments of Nariño, Cauca, and Valle del Cauca. Maintaining low variation over time is crucial to ensure timely project delivery and achieve established objectives.

These data are encouraging and demonstrate that it is possible to efficiently manage time in project execution. However, they also emphasize the need to continue improving this indicator, as less than 50% of completed projects have achieved this level of compliance. To achieve greater efficiency, it is essential to implement rigorous planning, maintain continuous monitoring, and promptly identify and resolve potential schedule deviations.

3.3.4 SPI, CPI, and SV(t) Summary of Compliance Rates

Figure 3 summarizes compliance rates for SPI, CPI, and SV(t), revealing consistent performance trends. Chocó leads in all three indicators, followed by Nariño, Cauca, and Valle del Cauca. The highest compliance across departments is with cost (CPI), followed by time variation (SV(t)), and lastly, schedule (SPI).

These insights support informed decision-making and continuous improvement in project management. They help identify departmental strengths and areas for enhancement, guiding targeted strategies to optimize indicator compliance and project outcomes.

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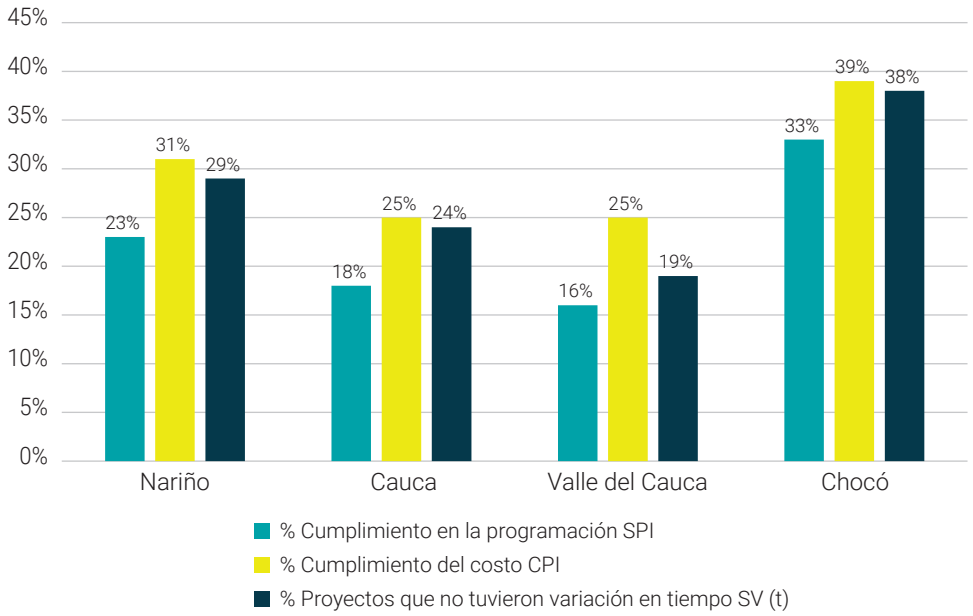

Figure 3. Summary of SPI – CPI and SV(t) compliance rates
Source: Prepared with data from [17]

It is critical to emphasize that compliance levels remain significantly low, with percentages below 50%. This highlights the urgent need for all four departments to intensify efforts to improve the execution of GSR-funded projects. The findings stress the importance of implementing effective strategies and strengthening project execution management. It is essential to optimize efficiency, monitoring, and control of allocated resources, while enhancing planning and coordination. Leadership and management capacity must be reinforced at all levels to ensure timely and effective project delivery.

Continuous improvement in project execution is vital to maximize resource utilization and achieve intended outcomes. A quality-, efficiency-, and transparency-centered approach should guide all project phases. Additionally, promoting collaboration and sharing best practices among departments is key to learning from successful experiences and addressing common challenges. Ultimately, the successful completion of projects ensures maximum benefits and the fulfillment of established objectives, including the timely delivery of expected products and services.

4. DISCUSSION

The management of royalties derived from the exploitation of non-renewable natural resources has become a critical issue on the public policy agenda due to its direct

impact on planning processes, proposal formulation, and resource allocation at the territorial level [22], [25]. Ideally, public policies governing royalties should promote sustainable economic development and environmental protection while adhering to principles of intergenerational equity and fiscal sustainability [24], [26].

However, a persistent gap exists between the normative objectives of these policies and their tangible outcomes. Despite significant resource transfers to beneficiary territorial entities, the social progress achieved through royalty investments remains limited. This phenomenon has been widely documented across various municipalities and departments, where investments often fail to translate into measurable improvements for local populations [1]. These findings underscore the need for critical review of existing public policies, particularly regarding planning mechanisms, implementation, and expenditure controls for these funds.

Consequently, royalty management poses not only a technical challenge but also a political and institutional one that requires greater attention from public policymakers [27]. Effective management should be based on criteria of transparency, citizen participation, and sustainability, as well as on an institutional structure that ensures efficient resource use. In this sense, royalties have the potential to serve as strategic tools for closing territorial gaps, improving quality of life, and generating high-impact public goods [26], [8].

Nevertheless, comparative analysis reveals that the effectiveness of public policies concerning royalties varies significantly between countries. While some have managed to implement more equitable and sustainable management systems, others show serious deficiencies in governance, accountability, and alignment with long-term development goals [4], [5], [6]. These concerns are further exacerbated by questions about the efficiency and real outcomes of these resources, even in contexts with relatively robust legal frameworks [28], [29].

Ultimately, the design and implementation of public policies aimed at royalty management require not only a technical and regulatory perspective but also a critical understanding of the institutional and social contexts in which these policies are developed. Only through such an approach can royalties fulfill their redistributive function and effectively contribute to territorial development and collective well-being.

In the case of this study, one of the most significant macroeconomic challenges in Colombia is the high fiscal deficit, which can hinder economic growth. This risk is exacerbated by the government's repeated failures to balance public finances through reductions in public investment [30]. Evidence also suggests that public investment is crucial in determining the trajectory of private investment and, consequently, economic growth [30], [31]. The World Economic Forum reinforces this by stating that

infrastructure investments not only enhance national competitiveness but also generate a positive multiplier effect on economic activity [32], [30].

Colombia is globally recognized for its abundance of natural resources [19], as well as for its gastronomic, musical, and historical diversity, and its varied geography [33]. However, this megadiverse country exhibits high economic dependence on activities related to mineral resource extraction [20] and faces significant infrastructure needs. Addressing these needs could substantially improve the country's productive and competitive indicators [32], [31]. The economic precariousness in some regions demands that resource availability depends on management efficiency [14], highlighting the necessity of implementing effective controls in the administration of allocated resources, particularly those within the General System of Royalties [15].

For the purposes of this study, the actor capable of mobilizing resources to achieve goals is considered the one who holds power [34]. Therefore, the responsibility for supervising the executed works—especially those financed with resources from the General System of Royalties—falls upon them [34]. Moreover, there is a positive correlation between infrastructure investment and economic growth [35], [13], since infrastructure development facilitates the extraction of local resources for consumption in international markets [13]. This makes it imperative to implement adequate compensation strategies for regions affected by resource exploitation [24] and to leverage the multiplier effect of infrastructure investment [35], [13], among other relevant aspects. This highlights the importance of identifying the lessons learned to optimize the General System of Royalties and maximize its impact on national development [3].

In this study, lessons have been identified regarding efficiency, effectiveness, and quality, based on the systematic review of projects under the General System of Royalties (GSR), highlighting several key areas requiring improvement to ensure project success. First, deficiencies in planning were identified as the primary cause of project issues. These include the lack of comprehensive studies and designs, and the absence of effective engagement with beneficiaries. Additionally, errors were detected in the information submitted for project approval, such as poorly defined indicators, location problems, and incorrect funding sources. These failures pose significant barriers to project success, impacting every stage from conception to execution.

Another major issue identified involves significant delays in the approval process, known as RAPAE (Registered, Updated, Prioritized, Approved, and Assigned Executor). These are compounded by difficulties in obtaining the licenses and permits necessary for project execution. Such delays negatively affect project timelines and progress, causing further setbacks.

Financial management also faces several challenges. Key issues include difficulties in budgeting processes and problems with payments from the General System of Royalties (GSR). The management of master accounts also presents challenges that must be addressed. These financial problems represent a critical barrier to efficient project execution.

Contractual management was found to have deficiencies both in the pre-contractual and contractual phases. Issues include delays in contract preparation and inadequate monitoring. Strengthening this area is essential to ensure efficient execution.

With respect to execution scheduling, the study identified a lack of detailed activity planning and weaknesses in monitoring and control. Addressing these is vital for efficient management during the implementation phase. Additionally, delays in license acquisition, missed deadlines, and deficiencies in construction quality were reported. Inadequate supervision and insufficient self-monitoring further complicate project delivery.

Finally, the project closure stage encounters difficulties in ensuring proper termination and implementation of control measures. Improving this phase is crucial for a successful and orderly project conclusion.

In summary, to ensure project success across all phases—from formulation to closure—it is essential to address these deficiencies and challenges by improving planning, financial management, contract management, execution, and closure.

4.1 Best Practices in Flagship Projects in the Pacific Region

The analysis identified several best practices in projects that successfully met efficiency indicators, such as SPI and CPI of 1.0 and SV(t) of 0.0. Key aspects were also evaluated, including resource adjustments and the ability to maintain schedules as initially established. Notably, the role of project managers from approval to closure was essential, as it allowed for the identification of concrete actions contributing to successful execution. From this analysis, lessons learned were collected to reinforce effective practices implemented by project managers. The main lessons are outlined below by key components.

4.1.1 Institutional Aspects Component

It was concluded that having budget availability to cover operational expenses—such as travel and lodging—is essential for effective project evaluation visits. Additionally,

the systematization of information, whether in physical or digital formats, is a crucial practice for optimizing access to information and reducing document management risks. Furthermore, clear assignment of responsibilities and constant oversight were identified as essential for ensuring the proper execution of all project phases. Regarding institutional transparency, the need for an environment free of scandals and corruption was emphasized to reinforce confidence in the process. Lastly, the implementation of results-based management, enabling continuous performance evaluation, also proved to be a key practice.

4.1.2 Project Prioritization Component

One important finding was the need for equitable territorial distribution of projects to ensure equal opportunities and contribute to reducing regional disparities. Furthermore, aligning projects with a national investment plan is fundamental for strategic resource allocation. Prioritization should also be based on criteria for closing gaps, considering social, economic, and environmental factors. Likewise, the use of participatory budgeting and community involvement in decision-making promotes transparency and strengthens public support. It is also important for projects to be viable and sufficiently updated, facilitating efficient management and reducing the risk of delays.

4.1.3 Selection Process Component

Lessons learned in this component underscore the importance of ensuring transparency in selection processes. Concurrent oversight and approval help ensure that procurement is carried out in compliance with regulations. Periodic audits and public bidding processes were found to be effective in preventing legal conflicts and ensuring process integrity. Additionally, continuous training of procurement staff and the establishment of autonomous, multidisciplinary evaluation committees enhance the quality and transparency of decision-making.

4.1.4 Project Design Component

A key lesson is the need for thorough problem verification before the project begins, which allows difficulties to be anticipated and resolved before affecting progress. It is also essential that technical documentation be ready within established deadlines, facilitating timely project execution. The use of innovative methodologies, such as

Building Information Modeling (BIM), has proven effective for integrated project information management. Concurrent supervision of technical documentation and shared responsibility between supervisors and designers ensure the quality of technical dossiers and minimize the risk of execution issues.

4.1.5 Project Execution Component

During project execution, the quality of prior studies and technical documentation was found to be fundamental in preventing problems, delays, and cost overruns. Additionally, periodically updating technical dossiers ensures that current project conditions are continuously considered. The use of control methodologies—such as tracking physical and financial progress and earned value—has been key to evaluating performance and making informed decisions throughout execution. Considering external factors, such as weather conditions, was also deemed essential to prevent unforeseen events that may cause delays or increase costs.

4.1.6 Risk Management Component

One of the main lessons in this component is the importance of recording and updating materialized risks as part of the risk management process, which supports continuous improvement and helps prevent recurring mistakes. It was also identified that the legal representative should possess risk management knowledge and play an active role in the process. Preparing regular risk and impact reports is essential for timely decision-making and effectively adjusting mitigation strategies. Lastly, holding informational workshops on risk management helps improve internal communication and fosters a culture of participation and collaboration.

CONCLUSIONS

In terms of scope compliance, the departments of Nariño and Chocó achieved the best results with 92% each, followed by Valle del Cauca with 89% and Cauca with 84%. Regarding cost compliance, Valle del Cauca led with 72%, followed by Chocó and Nariño with 71% each, and Cauca with 64%. In terms of time compliance, Chocó stood out with 26%, followed by Valle del Cauca with 17%, Nariño with 16%, and Cauca with 13%.

It is worth noting that despite receiving fewer resources and executing fewer projects, the Department of Chocó performed well in time and scope compliance and

nearly matched the top result in cost compliance. This is particularly significant given Chocó's challenges related to public order and climate conditions.

Furthermore, based on the SPI, CPI, and SV(t) compliance rates across departments, Chocó ranks highest, followed by Nariño, Cauca, and Valle del Cauca. The most consistently achieved indicator in all four departments is CPI, followed by SV(t), and lastly, SPI. The findings enabled the identification of best practices and lessons learned that contribute to successful project completion and responsible resource use. Projects with the best efficiency, effectiveness, and quality indicators fully complied with the scope, time, and cost established in their formulation, as well as with SPI, CPI, and SV(t).

The study also allowed for an analysis of the actions taken by officials from project approval to closure, identifying those that foster strong execution performance. Thus, lessons learned and effective practices were gathered and highlighted, aiming to serve as a practical tool for decision-makers.

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