THE COMPREHENSIVE PLAN OF ROAD REHABILITATION AND MAINTENANCE: AN ALTERNATIVE OF ROAD MANAGEMENT ARRANGEMENTS FOR DEVELOPING COUNTRIES

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ABSTRACT

The traditional maintenance policy of roads in Colombia has focused primarily on the implementation of targeted interventions aimed at rehabilitating the road sectors that are in critical condition and respond to emergencies through ineffective contract schemes, generating inefficiency in resource management and creating an unsustainable system of maintenance and road management in the medium and long term. In response to this problem, the Comprehensive Program of Rehabilitation and Maintenance (Plan Integral de Rehabilitación y Mantenimiento) was formulated by the National Roads Institute of Colombia, for the development of an overall management strategy for high-traffic roads outside the highway concession program, that can respond to the needs of financial resources management, definition and prioritization of interventions, customer service, and emergency response, through the incorporation of technical tools and new technologies provided by the private sector under an innovative contract system.

This paper presents an outline of the main characteristics of the Program that incorporates from its definition and design to its results and policy implications, based on the mentioned evaluations, and analyses the available information to develop a general strategy of road management that can be applied in the Latin-American context based on the Colombian experience.

Keywords: Road Management, Infrastructure Maintenance, Developing Countries

1. INTRODUCTION

In Colombia, as well as in many countries in the developing world, road infrastructure represents a central connecting mechanism between regions and allows the movement of a significant portion of goods and passengers inside the country. Given its geographical features, Colombia faces both advantages and challenges when determining the role of infrastructure in economic development. On the one hand, the country has a privileged geographical location that puts it in the middle of major economic markets. On the other hand, it has a significantly rugged topography, which is a challenge for transport development and hinders the construction and maintenance of infrastructure.

As result of the above characteristics, the need to work on the quality of infrastructure in corridors connecting production and consumption centers, in addition to providing rural accessibility for remote areas, represent key challenges. Trade growth has increased daily traffic of heavy vehicles on the roads across the nation, leading to an accelerated

deterioration that increases maintenance needs, affects transport costs and surpass the existing mechanisms for road management.

Colombia counts with approximately 166,233 km of road network, of which 16,771 km constitute the primary road system and approximately 85% of it is under the responsibility of the National Roads Institute [2]. Unfortunately, the maintenance scheme that have been applied on the main network has traditionally focused on specific interventions at high costs, often restraining or ignoring preventive and routine maintenance given limited availability of resources and budget cutbacks.

In order to respond to this problematic, the National roads Institute of Colombia have recently designed the Comprehensive Plan of Road Rehabilitation and Maintenance or PIRM[1] according to its abbreviation in Spanish, which is an integral road management scheme for the main road network that engages private and public actors under long-term contracts in order to rehabilitate, administrate and maintain central corridors of national road network.

After five years of its implementation, the PIRM has achieved positive outcomes in terms of quality increase and sustainability of the road infrastructure in the eleven corridors where it has been applied, as found in evaluations executed in different terms of the program. The main results of the program evaluations will be summarized in the following sections of this article, emphasizing in the advantages and disadvantages of the road management scheme and its transferability to other contexts with similar conditions in order to formulate a general guideline of road management arrangements for developing countries.

2. PROBLEM DEFINITION

Maintenance problematic in Colombia is mainly related to limited availability of resources, inefficiency in road management, and lack of a long-term planning culture in infrastructure programs. This combination of facts has led to the accelerated deterioration of the road network and preserved the detrimental tendency that has affected the development of transport infrastructure in the country over the past decades.

Main financial difficulties are related to limited budget availability and disordered distribution of monetary resources. Regularly, yearly budget allocation has to be employed in preservation and building of new roads, emergency response, and the State contribution to new concession projects, which considerably limits the extent of maintenance investment. Moreover, budget allocation of the National Roads Institute for maintenance has been substantially reduced from an average of $300 million USD per year in the mid-nineties to approximately $150 million USD in 2003 [2].

Preventive and periodic maintenance have not been a priority in road investment in recent years, which affected infrastructure sustainability and reduced budget allocation for roads in fair and good condition in comparison to the resources assigned to corridors that need rehabilitation. The costs of not performing adequate maintenance during the life cycle of a

[1] Plan Integral de Rehabilitación y Mantenimiento

corridor are clear. On the one hand, it is more expensive for the government to invest in reconstruction and rehabilitation than to ensure funding for a maintenance program. On the other hand, savings in operating costs of vehicles circulating in well maintained roads exceed the investment that an optimal maintenance program may require [4].

Investment costs in comparison to the damage increase of a given corridor are resumed in figure 1.

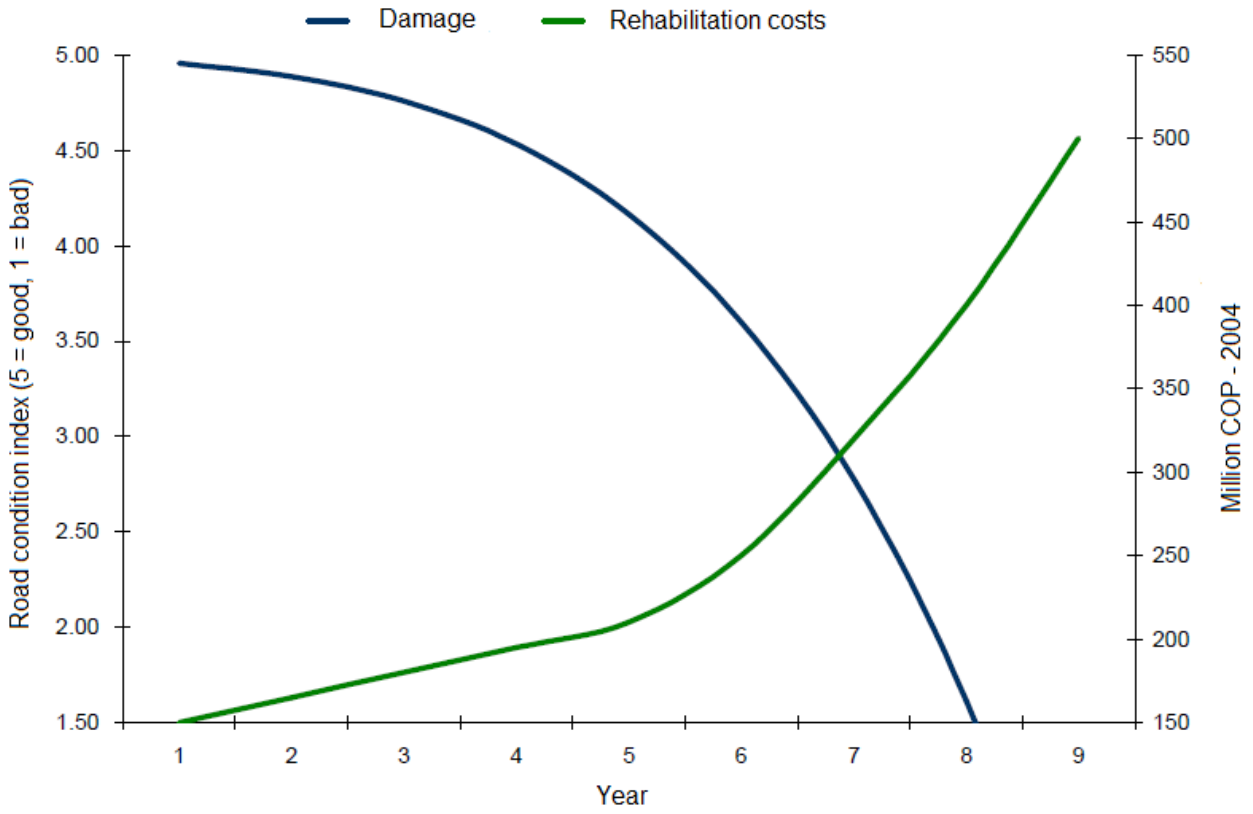

Figure 1 – Rehabilitation investment cost Vs. Damage of infrastructure [5]

In practice, roads endure an absence of a responsible figure that helps allocating resources to priorities of infrastructure and defining satisfactory time horizons to perform timely interventions. Lack of information related to the evolution of the road network contributes to limited planning schemes and reduced response capacity to contingencies. In addition, the focus of contractors and road engineering companies on physical interventions make traditional maintenance schemes unsustainable, and requiring the formulation of a management strategy that allows restoration and maintenance of infrastructure under the same budget and technical constraints.

Traditionally, road administration has focused on specific interventions generating inefficiency in management models. Short-term engagements with specific goals have led to the proliferation of countless contracts, most of them for the rehabilitation of sections of the network that are in critical condition. As a result, problems like high administrative costs, inefficiency in resource management and high investment in monitoring and control mechanisms emerge, producing a vicious circle that preserved the continuous damage of road infrastructure.

Main stakeholders and facts involved in the road management problematic are summarized in figure 2.

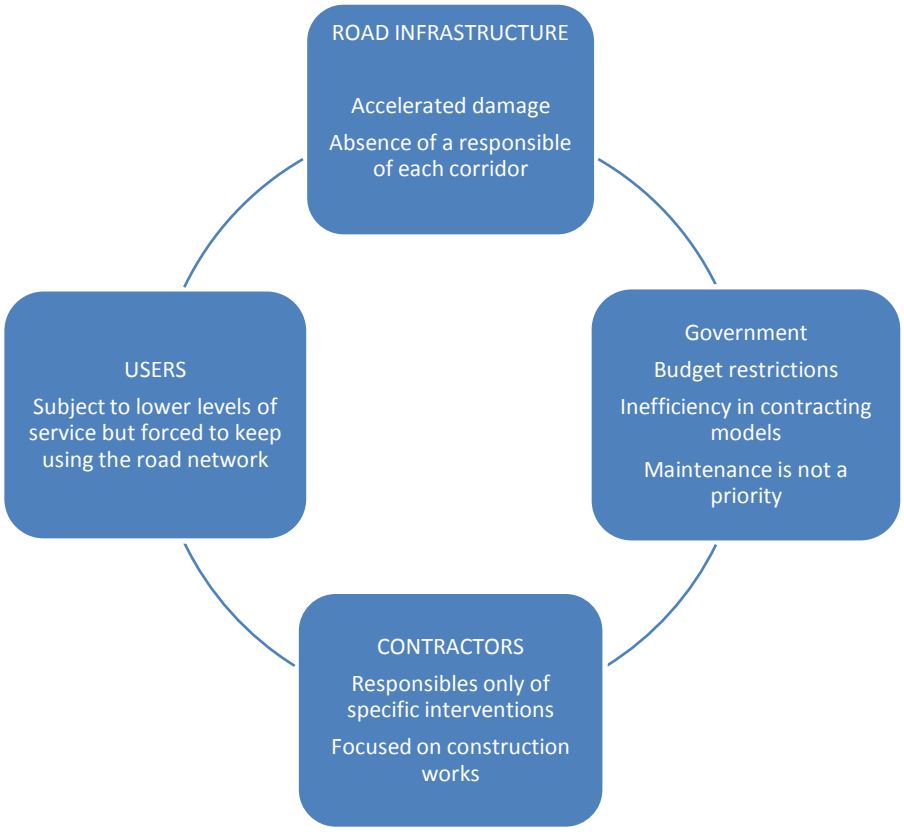

Figure 2 – Main aspects and stakeholders involved in the maintenance problem [1]

3. THE PROGRAM

3.1. Policy guidelines

In 2004, the National Council for Economic and Social policy -CONPES- defined the Comprehensive Road Infrastructure Policy, which includes the description, justification and specification of the impacts and outcomes of the Comprehensive Program for Road Rehabilitation and Maintenance. In recent years, infrastructure development and sustainability have progressed substantially as result of the implementation of rehabilitation and improvement strategies that achieved important milestones in terms of recruitment, resurfaced miles, and miles in good condition [2].

The Comprehensive plan for road rehabilitation and management is framed within the strategic objectives of the National Roads Institute, which are focused on the development of the national road network and attainment of regional integration through the strengthening and maintenance of the existing infrastructure. In this regard, the PIRM seeks to respond to the objectives of restoring and maintaining the main road network under the responsibility of the roads institute by including in its budget allocation the main corridors of this segment of the national road infrastructure [3]

The Integral Road Policy emerges from the necessity of improving traditional programs carried out on road maintenance, which were mainly characterized for their limited extent, high administrative and intervention costs. The first kind of these interventions, devoted to specific treatments, engaged private actors during a short period for rehabilitating only the most critical areas of a given corridor. The second type of programs, also focused on targeted interventions, was part of an emergency response system that considered extremely short deadlines, in which the Roads Institute assumed the full costs of personnel and logistics, increasing the repairing costs, and contributing to the inefficiency in budget employment.

In the case of the PIRM, it does not involve any substantial component of previous initiatives seeking to assure sustainability of interventions towards long-term contracting schemes. One of the main strengths of the program is that it integrates the required interventions that a single corridor may require during the term of the contract, which generates savings on time and procurement costs and allows a direct response to the needs of the road. The Comprehensive Plan responds to the need of an optimization in the cycle of planning and budget allocation, procurement, financial management, evaluation and monitoring in road management.

3.2. Program Design

The design of the Comprehensive Plan of Road Rehabilitation and Maintenance seeks to respond to the needs of the busiest sections of the national network, while evading most of the previous flaws in traditional schemes. Main characteristics of The PIRM's contracts are that they consider long terms (5 to 6 years), which are ideal for the cycle of periodic maintenance, and involve an intervention program similar to the maintenance component of a concession contract. In addition, they perform regular maintenance along the entire extension of each corridor and rehabilitate their most deteriorated sectors in order to maintain service levels established from the contract [4]

A strong point of the program is its capacity for generating information, which represents an important asset that distinguishes the PIRM from previous initiatives. The intervention plan specifies continuous monitoring of pavement condition and traffic evolution as well as production of service level indicators that are used for planning and evaluation of maintenance activities. In that order, the PIRM seeks to optimize the planning cycle in road management by employing useful data that serves to an adequate distribution of resources and times.

In order to guarantee an adequate quality in data generation and evaluation processes, the contracting process of the program evaluates technical capacity and personnel qualifications of each engineering and construction firm, prior the adjudication of the contract. This is an important requirement for the satisfactory development of the planning and evaluation activities given that the PIRM requires the generation of HDM models and constant technical advice in order to generate good quality intervention plans.

In addition, the PIRM design contemplates payment by results based on evaluation indicators that lead to fixed discounts in case of failure in meeting quality requirements.

This remuneration scheme allows the Roads Institute to establish incentives for contractors and ensure a stable and adequate flow of resources along the contract term.

The Comprehensive Plan's scheme considers three innovative components that are central in its integral scope: Road Administrators, Microenterprises for Routine Maintenance, and Centers for Costumer Service.

The first of them, Road Administrators, is a figure previously created by the Institute in order to monitoring the needs of a given corridor *in situ*; the administrator has the responsibilities of continuously monitoring the road, supervise and coordinate routine maintenance activities, and helps to identify specific needs or emergencies that are not considered on the intervention program. The second component, the Microenterprises, involves inhabitants of the corridor's vicinity for performing routine maintenance (mainly cleaning and surface maintenance) that guarantees daily serviceability. Finally, the centers for customer service represent an initiative for incorporating user attention and quality control in the road emulating some of the characteristics of a concession project [1].

The components produced by the plan can be divided into two phases according to its schedule of implementation, the pre-operational phase and the operational phase. During the first phase, diagnostic and planning activities are performed according to the needs of each corridor, while in the second phase direct interventions, emergency response and evaluation and monitoring activities are implemented [1]

Main activities of the pre-operational phase include preliminary technical studies related to evaluation of the corridor's characteristics, traffic studies, geological stability assessment and superficial and structural pavement diagnosis. Based on technical studies and economic and financial assessments it is then formulated the plan for the execution of interventions for homogeneous sections.

In the first phase it is also implemented the administration of the corridor involving interventions planning, personnel and information management, emergency management, etc. Additionally, environmental and social plans, and physical facilities required for the development of the contract are acquired during this period.

In contrast, management activities during the operational phase include the most representative: participation and management in the prevention and attention of emergencies, procurement actions, planning, organization, and evaluation of activities, routine maintenance, preventive maintenance, periodic maintenance, signalization, safety infrastructure, and structural repair and strengthening. These activities represent the core of the intervention program that aims to ensure the sustainability of road infrastructure in the long term.

Major monitoring, control and planning of the program are also performed in the operational phase each year. The respective contractors of each corridor take field measurements of roughness indicators, pavement condition and other relevant information for reclassification of homogeneous sections of the road and input for the HDM-4, which will modify the array of interventions according to the current needs of the pavement in the different sections of the corridor.

For verification of compliance of construction activities, a periodic monitoring by the supervisor of the contract is also considered in order to implement the necessary corrective measures in a timely manner. These activities are complemented by the annual evaluation and technical committees that establish periodical changes to the investment needs and budget prioritization. With regard to the means of verification of road management activities, assessments are made, supplemented by regular reports submitted by the contract manager's supervisor.

3.3. Main results

After 5 years of the PIRM's implementation, there were identified positive results given that budget and physical targets were met in most cases. In terms of schedules and targets, there was identified a good performance since delays in budget execution were less than 8% in all corridors covered by the program.

Periodic quality verifications, monthly and annual evaluations evidence a large success in ensuring the quality of both goods and services provided by the program. Besides the possibility of imposing discounts to contractors for violations or failures in the quality of the components, the program has guaranteed, according to reports of Supervision and monitoring of contracts, quality interventions that substantially improved the level of service in a manner that respond to the needs and conditions of each corridor.

Main results of the PIRM are related to a considerable improvement in the level of service of all corridors, including increases in safety, comfort, and travel speed. In addition, a substantial increase in daily traffic on the majority of the roads was also identified.

As consequence of the program, 64% of the covered network length has been restored and maintained in good condition, compared to the initial 11% in 2005. Moreover, the percentage of miles in poor condition was reduced from 32% to 12%, and the portion of roads in fair condition changed from 57% to 24% between 2005 and 2009. Similarly, emergency management, installation of both horizontal and vertical signs, routine maintenance and road management has allowed road availability of over 90% of the year, even in the areas of greatest threat of emergencies, significantly increasing the perceived level of satisfaction and security of the users [1]

4. LESSONS FROM THE COMPREHENSIVE PLAN OF ROAD REHABILITATION AND MAINTENANCE

The Comprehensive Plan raises some interesting innovations that have proven successful in the efficient use of scarce resources for road maintenance. The main lessons from the program are summarized in figure 3.

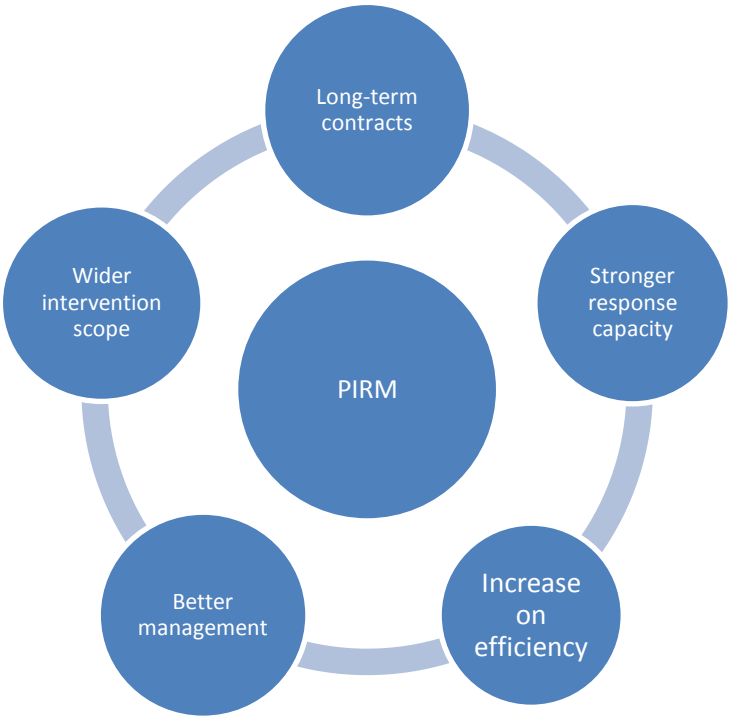

Figure 3 – Main strengths of the Comprehensive Plan for Road Rehabilitation and Maintenance

Longer-term contracts: The contracting model has been modified, migrating from short and specific contracts to longer engagements with a wider scope. Short-term contracts were designed to repair specific pavement failures and failing in many cases to resolve the underlying structural problems. By changing contracting terms to five-year engagements, contractors were allowed to strengthen their organizational structure and improve their management strategies.

As a result, contractors invested in material plants, technology and personnel. Acquiring own equipment of better quality and assembling more stable work teams for administrate long road sections. This generated lower administrative costs and facilitated control and effectiveness in comparison to the scenario of multiple short-term contracts with explicit scope.

A new "business": In the PIRM, road engineering companies had to create new profiles, new knowledge and new methodologies for road management and maintenance activities. This new job involved appliance of HDM models, diagnose of maintenance needs and prioritization of investment, linked to the prevailing traffic conditions.

Consequently, experts in road maintenance turned from specialists in repair and reconstruction of roads, to analysts and professionals in intervention planning, monitoring and timely priority detection, and developing new approaches to traditional road maintenance activities.

An administrator of the road corridor: With the assignment of major corridors of the national network to road engineering companies, road management of good quality was guaranteed. In addition to routine maintenance activities (cleaning of signs, repair of

cracks, vegetation clearing), the existence of a constant monitoring and control of road evolution and requirements allowed to comprehensively address problems associated with invasion of the corridor's surrounding areas, emergency care and other sporadic needs.

This new scheme, summed up to the response capacity of a road management firm, allowed significant results in terms of managing optimization and road supervision.

An efficient program: From the perspective of economic efficiency, planning for annual maintenance schedules and procedures for prioritizing resources generate significant savings in maintenance investment, while contributing to produce savings in operating costs.

Better management of public entities: The ex post and executive evaluation of the PIRM showed that the management of public institutions and tasks distribution between them and the private sector improved. Positive indicators related to the achievement of goals, proper structuring of the program, satisfactory performance of the recruitment offices and target meeting, evidence the achievements of the comprehensive plan in terms of management optimization.

5. A ROAD MANAGEMENT STRATEGY FOR DEVELOPING COUNTRIES

The PIRM experience could serve in part to the implementation of road maintenance strategies in other developing countries.

Structured in an appropriate contractual framework with effective control systems, the PIRM strategy could generate significant savings to public agencies in charge of road maintenance while contributing to increase competitiveness and reducing operational costs. In addition, technical capacity building for the definition of maintenance requirements, quantification, and programming prioritization in the medium and long run, are central assets in the development of a road management strategy.

The engagement of private sector companies for conducting these activities also appears to be desirable. However, it is important that public agencies in charge of resources and their allocation also acquire the know-how generated in the process of implementation of contracts, and to count with timely updated information systems.

Main strengths of the PIRM approach that can be adopted in a general management strategy for developing countries are:

1. Long-term contracts for road management instead of only repairing interventions.
2. The role of public agencies as supervisors and long-term planners.
3. Capacity building for ensuring quality in the production of both physical components and information needs.
4. Constant data generation for planning and evaluation.
5. Implementation of economic incentives to guarantee opportunity and quality in the production of components.
6. Assignment of a permanent responsible of the road needs *in situ.*
7. Incorporation of emergency response schemes in addition to preventive, periodic and routine maintenance of infrastructure.

8. Inclusion of complementary activities that serve to the increase of service level and safety (i.e. signalization).
9. Transferability of expertise of both the private actors and public agencies involved in the program.

6. CONCLUSIONS

Main difficulties in road management in developing countries are related to poor availability of information and accelerated deterioration of the road network. Consequently, continuous data generation for planning and evaluation of road evolution represents a primary need in the development of road management strategies. This asset can contribute to the development of an adequate intervention plan that responds not only to the immediate needs of transport infrastructure but to the sustainability of roads in the long term.

However, periodic data generation and intervention planning and execution require sufficient technical and human resources competence in addition to adequate resources allocation for assuring quality in production of components. This influences directly contracting schemes and increases requirements for road engineering companies to participate in integral road management contracts. Knowledge transferability and modernization of traditional processes are central requirements in the implementation of integral management schemes.

This combination of requirements alone is not sufficient for integral administration of road infrastructure. An adequate contracting term for performing the required interventions of a given road and take advantage of the additional capacity response requested to engineering companies. In that sense, the PIRM's contract term has proven to be successful achieving important results along its 5-year term, which makes it advisable for the implementation of future road management schemes.

This strategy was very useful in increasing and maintaining service levels in the busiest roads of the main network in Colombia. However, after its consolidation on the rest of the central road network, it is important to extend these models to secondary and tertiary roads by developing a sustainable funding and contracting scheme for the adequate maintenance of the rural road system.

In terms of its transferability of other developing countries with similar characteristics with Colombia, it is required to consider not only data requirements and contract specifications, but it has to be considered an adequate funding mechanism that contributes to the program sustainability in time.

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