

PAVEMENT MANAGEMENT SYSTEM AND MODELING OF SUSTAINABLE ROAD MAINTENANCE PROGRAMS OF DER MINAS GERAIS

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Abstract: Pavement Management System - SGP is understood as the mutual interaction of a set of thematic axes for planning, design, construction and maintenance of pavements and other elements of the road network. In a planning context of a highway organization, such as the DER-MG, the SGP must be used to establish budget levels that minimize the total cost of the road modality, enhance maintenance and construction programs, maximize the net present value of a road network in short, medium and long term perspectives, considering public policies of budget restriction. Seeks to optimize the quality of our highways, offer safety to drivers, passengers and pedestrians, as well as favoring the development of the sector and economic growth; interacting this way with some of the goals and targets set by the UN in the 2030 Agenda, which addresses the main development challenges to achieve a better and more sustainable future for all people in Brazil and in the world. The Sustainable Development Goals - SDG aim to guide national and subnational policies, with each federative entity assuming a role of protagonist in development. Thus, for the 2030 Agenda to be effectively implemented, governments are responsible for managing various policies that contribute to achieving the SDGs, for example the SGP. The SGP has the following strategic guidelines: Act in a coordinated and intersectoral manner, observing the components of planning, design, construction, maintenance, rehabilitation, evaluation and research of pavements; value the efficiency of public investments available for the management of the state road network; seek safe, compatible and economical road transport; seek alternatives to increase the efficiency of transport logistics; and adopting partnerships with civil society that contribute to the achievement of its objectives.

Keywords: Pavement Management, Planning,

Sustainable Development Goals - SDG, ESG, Road Maintenance.

INTRODUCTION

Roads are an asset of high heritage value, both for the material resources deposited there and for the service they provide to society, ensuring accessibility and allowing the movement of populations and goods. According to Liedi Bariani Bernucci... [et al.] (2006, p.9)

Pavement is a structure of multiple layers of finite thickness, built on the final surface of earthworks, designed technically and economically to resist efforts arising from vehicle traffic and the weather, and to provide users with improved running conditions, with comfort, economy and security.

Pavement Management System - SGP is understood as the mutual interaction of a set of thematic axes for planning, design, construction and maintenance of pavements and other elements of the road network. The name Pavement Management may convey an idea of managing only the pavement structure, however Management is much larger, covering all road assets. Due to the importance of this asset, the System earned its name.

The Pavement Management System deals with a set of tools that help define strategies for the highway agencies, both for maintenance and for the design and construction of new stretches. Decisions through the implementation of the System are based on objective data, which allows for more efficient interventions.

The data collected includes elements of geometry, drainage, signaling, traffic and pavement pathologies such as cracks, patches, pans, sinking, undulations and deflection, among others. This data provides valuable insight into the condition of the pavement, which allows highway agencies to identify and anticipate problems to better prioritize

maintenance.

This work aims to present the strategy for restructuring the Pavement Management System - SGP and modeling sustainable road maintenance programs within the scope of DER-MG.

CONTEXTUALIZATION OF THE SGP IN MINAS GERAIS

Minas Gerais has the most extensive road network in the country. According to the latest CNT de Rodovias surveys (2021) - the largest assessment of road infrastructure in Brazil, carried out by the National Transport Confederation - the panorama is of worsening indices over the years, as shown in figure 1 below:

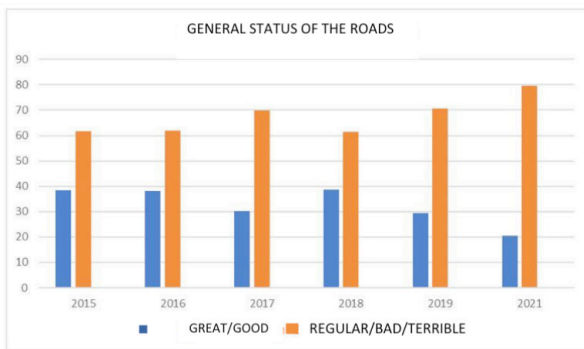


Figure 1 - General State of Highways - CNT (2021)

Given this scenario, and in pursuit of economic recovery, investing in infrastructure is the most coherent way to achieve a new cycle of sustainable development, with job creation and income distribution for the population. Optimizing the overall performance of the road network over time, in line with the objectives of a network restructuring policy within budgetary constraints, aims to minimize transport costs, preserve asset value, provide and maintain accessibility, and offer a safe and ecological transport. According to figure 2 below, the optimal level of maintenance

corresponds to the intersection between the user cost curve and the Agency cost curve.

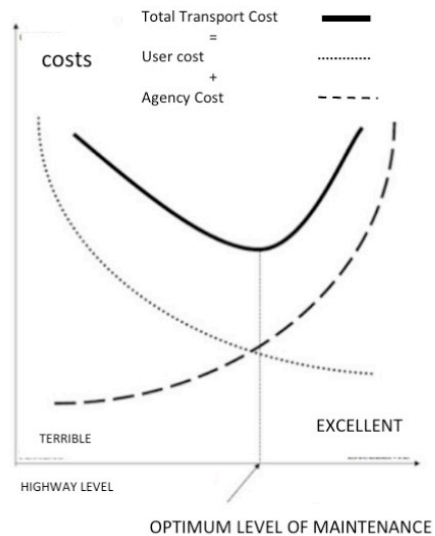


Figure 2 - Graphical representation of the total transport cost as a function of the highway's maintenance level(CAUE)

The DER-MG had, for a long time, an SGP in operation, implemented in 1984 with the help of the DNER in order to serve the federal network delegated to Minas. In the 1980s and 1990s, it mobilized a large SGP team that, in the manner proposed to serve the then Highway Design Maintenance - HDM III, had the help of several technicians: from the then DNER, BIRD, USP; DER-SP, IPR. In 1990, a survey was carried out covering the entire paved road network (state and delegated), and these surveys were repeated in 1993 and 1996. It is worth noting that there is much underused information contained in projects, studies, surveys, inventories, etc. Rehabilitating them and inserting them into a GIS (Geographic Information System) database will make them active and thus accessible at any time.

The state of Minas Gerais has already adopted international concepts in road maintenance management, but studies with greater technical and economic criteria employed in a Pavement Management

System, with long-term strategies, have been minimized. Part of the programs were/are interrupted due to insufficient or discontinued financial resources, which must be designed to be continuous, regular, uniform and sustainable.

In a period in which we are facing economic difficulties, financial scarcity advises decision-making agents to exercise greater rigor and special care in the attribution and management of budgets, rationing the available resources according to well-founded criteria. The consolidation of the economic recovery process and the expansion of investments in infrastructure is the most coherent way for us to reach a new cycle of sustainable development, with job creation and income distribution for the population. The effort to expand and improve the quality of highways requires accurate information, adequate planning and investments in road infrastructure.

PROJECT JUSTIFICATION - SGP

Highways quickly lose value when they are neglected in terms of conservation, maintenance and restoration care. The SGP will reveal the best relationship between investment and benefit, respecting allocated budgets and maintaining quality levels and the best conditions of use for the user.

Due to the variation in the condition of the network with time and traffic, the maintenance of the general register of highways, through the SGP, is necessary, aiming to establish performance standards through acceptance criteria, meeting the demand for improvements in the state road network.

However, for a perfect diagnosis of state highway conditions and efficient strategic planning, it is necessary to constantly maintain the SGP database with updated and reliable information, acquired from on-site surveys, materialized in the General Register.

Based on the restructuring of the SGP

and the sustainable management of the state highway network, it is expected to meet society's demand for improvements in the quality of state highways. By encouraging the conception, development, contracting and use of new tools, techniques and technologies, it is expected to contribute to a greater systematization and speed of the management information necessary for the evolution of the road transport system and the guarantee of quality of the engineering services provided.

In addition, efforts are being made to optimize the management of budgetary and financial resources and achieve a better compromise between available resources and the public service provided.

PROJECT DESCRIPTION

DER-MG made Public Notice 110/2021 public for consultation, the object of which deals with specialized engineering services for technical and operational support to the processes of updating the General Registry of Highways, restructuring the Pavement Management System - SGP and management of the state road network, where it defines the new management model for the state road network, as an interaction of the set of thematic axes for planning, design, construction and maintenance of pavements and other elements of the road network, where it uses reliable information and criteria decision-making to produce programs that enhance the efficiency of investments, helping managers to find better network management strategies, in order to optimize pavement conditions throughout the network.

The project consists of two main fronts of action:

1. The **general register of highways** with the collection of objective data from more than 25 thousand kilometers of road network (the entire paved and unpaved extension of the state of Minas Gerais), in

addition to the volumetric traffic count in more than 900 permanent, coverage and seasonal counting posts. This register will identify, in a georeferenced way, the road elements that will be part of the new database with map application. Traffic data, geometry, Continuous Visual Survey - LVC, Survey of Longitudinal Irregularities - IRI, Survey of Deflections (Falling Weight Deflectometer) - FWD, Survey of Depression of Wheel Tracks - ATR, among others, will provide essential information for defining the status of road assets, allowing better decision-making by managers.

2. The second major front consists of

intelligence generation through of **specialized team for local support**, in the office treating the data collected in the field.

Products will be generated such as:

- SGP Diagnostic Report;
- State Plan for Traffic Counting;
- DER-MG Solutions Catalog;
- Minas Gerais Road Maintenance Program;
- Revision of the road maintenance contractual model.

Below in Figure 3, we present the summarized timeline of the project until the present moment..



Figure 3 - Project timeline

ALIGNMENT OF THE SGP WITH THE ENVIRONMENTAL, SOCIAL AND GOVERNANCE - ESG AND SUSTAINABLE DEVELOPMENT GOALS - SDG

In 2015, Brazil, together with 192 other countries and civil society groups and stakeholders, gathered at the United Nations (UN) Summit to elaborate a new sustainable

development agenda. That meeting resulted in 17 new Sustainable Development Goals (SDGs), which were based on the eight Millennium Development Goals (MDGs). Also known as the 2030 Agenda, the SDGs have 169 specific goals, involving diverse themes that seek, by 2030, to make progress on goals not achieved.

Figure 4 lists the SDGs.



Figure 4 - Sustainable Development Objectives

Source: United Nations - Brazil. Available in <https://nacoesunidas.org/pos2015/agenda2030/>.

Aiming to meet the 2030 Agenda, the Government of the State of Minas Gerais launched in its projects the *Environmental, Social and Corporate Governance – ESG*, which impacts the workforce, improves the State’s image, fosters innovation, generates economic growth, establishes strategic partnerships and positively impacts society as a whole.

In this sense, the ESG is in line with the 17 UN Sustainable Development Goals. In this context, the SGP seeks to corroborate the objectives and targets proposed by the 2030 Agenda, and considering the aspect of

transversality that characterizes not only the actions of the SGP, but the understanding of the road infrastructure as a whole, it is understood that success in fulfilling of some objectives and goals can contribute, as a consequence, to the achievement of sustainable development. This way, efforts were made to establish synergies between the goals proposed in the Pavement Management System and the other Objectives present in the 2030 Agenda, especially those related to objectives 3, 8, 9, 12 and 16.

	<p>Objective 3. Ensure a healthy life and promote well-being for everyone, at all ages. 3.6 - By 2020, halve global road fatalities and injuries. 3.6.1 - Mortality rate due to traffic accidents.</p>
	<p>Objective 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. 8.1 Sustaining per capita economic growth in accordance with national circumstances and, in particular, at least 7% growth in gross domestic product per year in least developed countries. 8.2 Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high value-added and labor-intensive sectors. 8.3 Promote development-oriented policies that support productive activities, the generation of decent jobs, entrepreneurship, creativity and innovation and encourage the formalization and growth of micro, small and medium-sized enterprises, including through access to financial services. 8.9 By 2030, develop and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products.</p>




 <p>9 INDUSTRY, INNOVATION AND INFRASTRUCTURE</p>	<p>Objective 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.</p> <p>9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and cross-border infrastructure, to support economic development and human well-being, with a focus on equitable and affordable access for all.</p> <p>9.1.1 - Proportion of population residing in rural areas living within a 2 km radius of access to a road passable in all seasons.</p> <p>9.1.2 - Passengers and cargo carried by mode of transport.</p>
 <p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p>	<p>Objective 12. Ensure sustainable patterns of consumption and production.</p> <p>12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.</p> <p>12.4 By 2020, achieve environmentally sound management of chemicals and all wastes throughout their lifecycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.</p> <p>12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.</p>
 <p>16 PEACE, JUSTICE AND EFFECTIVE INSTITUTIONS</p>	<p>Objective 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.</p> <p>16.1 Significantly reduce all forms of violence and related death rates everywhere.</p> <p>16.6 Develop effective, accountable and transparent institutions at all levels.</p> <p>16.7 Ensure responsive, inclusive, participatory and representative decision-making at all levels.</p> <p>16.10 Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements.</p>

Table 1: Synergies between SDG and SGP proposals.

Source: <https://brasil.un.org/pt-br/sdgs>

FINAL CONSIDERATIONS

Considering budget restriction public policies, in short, medium and long term perspectives, the Pavement Management System must always seek to optimize the quality of the highways; offering safety to drivers, passengers and pedestrians, as well as favoring the sector's sustainable development and economic growth.

It is expected that the SGP will have impacts on the quality of roads for users, and above all, better management of the scarce resources available, in a more rational way, establishing intervention priorities, giving weight to criteria and technical recommendations in decisions, and greater transparency.

With this, it is intended:

- Minimize transport costs,
- Preserve the value of assets,
- Provide and maintain accessibility for users,
- Reduction of vehicle operation costs,
- Travel time savings,
- Accident reduction,
- Stimulation of regional development,
- Increased comfort and convenience

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