

## **TACTICAL VEHICLE REQUIREMENTS WITH CIVIL OR MILITARY APPLICATION: A PROPOSAL**

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**ABSTRACT:** This paper aims to propose the necessary technical specifications to be adapted to 4x4 vehicles for police vehicles in rural and urban areas of the state of Bahia, considering aspects of ergonomics, performance, and interior space. The research methodology is defined as argumentative. The theoretical framework discusses the operational dynamics of the Military Police of Bahia (PMBA), the availability of specific equipment for public security activities by the national industry, and a set of basic requirements to ensure the fulfillment of police forces' needs supported by technologies. The study concludes by advocating the adoption of Basic Operational Requirements suitable for state police operations in harsher environments for police work.

**Keywords:** 1. Tactical Vehicle; 2. Police Operations; 3. Requirements Procedures.

## **REQUISITOS DE VEÍCULO TÁTICO COM APLICAÇÃO CIVIL OU MILITAR: UMA PROPOSTA**

**RESUMO:** Objetiva propor especificações técnicas necessárias a serem adaptadas em veículos 4x4 para viaturas policiais nas áreas rurais e urbanas do estado da Bahia, observando as questões de ergonomia, desempenho e espaço interno. Definido o método argumentativo na condução da pesquisa. O referencial teórico relata a dinâmica operacional da Polícia Militar da Bahia (PMBA), a disponibilização, por parte da indústria nacional, de equipamentos específicos para as atividades de segurança pública e um rol de requisitos básicos para assegurar o atendimento das necessidades das corporações policiais apoiado em tecnologias. O estudo conclui pela adoção de Requisitos Operacionais Básicos, adequados para as operações policiais estaduais em ambiente mais hostil para o trabalho policial.

**Palavras-chave:** 1. Veículo Tático; 2. Operações Policiais; 3. Requisitos Operacionais.

## 1 INTRODUCTION

The large territorial dimension of Bahia, combined with its diverse biomes, demands a lot from the police vehicles in use, especially in rural policing. In these environments, the patrol vehicles are highly challenged as they traverse both paved and unpaved road sections, encountering various adversities such as watercourses, rain erosion undulations ("cow ribs"), as well as uphill and downhill terrains with poor traction, putting strain on the entire mechanical and structural components of the vehicle, in addition to discomfort for its occupants [1].

Currently, in Brazilian police forces, utility 4x4 vehicles assembled or imported by manufacturers established in Brazil are used. However, even when these vehicles are adapted for police use, they still have numerous limitations for off-road deployment. These limitations even compromise the state's financial aspect, resulting in wastage of public resources both during acquisition and frequent corrective maintenance due to the severity of use [1].

In the mid-1970s to 1980s, Brazil had specific domestic production of military vehicles for national defense, primarily directed to the Army and Navy, and even became an exporter of these vehicles to foreign forces, according to Bastos [2]. Despite the similarity in operational requirements between the Military Police (PM) and the Army, there is no evidence of domestic manufacturing of vehicles specifically designed solely for police operations in urban and rural areas.

Alongside the literature research, documentary studies and research were conducted with the Bahia Military Police. Particularly, research conducted with the Department of Logistics Support [3] shows that in the state of Bahia, approximately 8 million Brazilian Reais were invested annually in the last six years for the acquisition of vehicles for the Military Police of Bahia (PMBA). This amount was solely for the owned fleet, as there are also leased vehicles under loan and commodate agreements. Notably, these vehicles are acquired from manufacturers that produce civilian vehicles, not specifically designed for police activities, necessitating the addition of certain requirements.

According to PMBA [3], it was observed that the average cost of a 4x4 pickup truck for regular use currently amounts to R\$ 260,000.00, and the average cost of adapting a vehicle for police operation, whether civilian or military, is close to R\$ 40,000.00, including the installation of a cell, radio equipment, branding, and accessories.

Additionally, it was found that the average cost of preventive and corrective maintenance for a civilian 4x4 vehicle is R\$ 950.00, whereas in comparison to the police version used in rural and urban areas, it is around R\$ 1,700.00 [3].

Moreover, the service life of a vehicle has variations according to the mode of operation, with the most significant wear typically related to maintenance items. The wear and tear of tires and filters require more frequent replacements, especially considering rural use, both for civilian and police applications, leading to more frequent inspections and tire changes [4].

In this context, there is a need to adapt existing parts in the national automotive market, foreseeing a quick overhaul through the vehicle's modularity for each mission. According to Henriques and Miguel [5], modularity is a strategy adopted by various industrial sectors, be it in product development or industrial production configuration.

Thus, there is a family of conventional vehicles for commercial use, but with adaptations and an increase in ideal requirements, utilizing the same platform to allow for versatile logistics, standardization of most spare parts, and rationalization of investments.[5]

Moreover, modularity will also serve to reduce vehicle production costs, with a lean production line, requiring fewer employees, using the same platform as a base, to which structures would be added according to orders, thereby avoiding the waste of financial resources by the manufacturer [2].

Another aspect justifying this study is the ongoing need for the adaptation and improvement of police vehicles to meet the specific requirements and challenges faced during policing operations, particularly in the diverse and demanding terrains of Bahia [1].

Another point justifying this study is the need for defining technical requirements that enable better operational performance using modular technology [6]. There is also a need to conduct a product life cycle analysis, which describes its entire trajectory from ideation to the end of support.

Given this fact, one can consider the development of specific requirements for use in a 4x4 vehicle that will serve as the foundation for various police applications, including armoring, while also utilizing existing parts and spare parts in the national aftermarket, thereby facilitating maintenance logistics and reducing the costs of development, acquisition, and operational use.

Consequently, the research question arises: Is it possible to define technical and economic requirements that can ensure the required performance of patrol vehicles, assisting in state procurement processes or new vehicle developments for this purpose?

To address this, the general objective is to propose some technical specifications to be adapted in a family of 4x4 vehicles for use as tactical vehicles for public security in rural areas of the state of Bahia. Consideration will be given to ergonomics, performance, and interior space for users, aiming at their various applications. The specific objectives are as follows: Diagnose the main problems encountered in the use of tactical vehicles in public security in rural areas of Bahia; Conduct qualitative and quantitative research with individuals involved in the daily use of the patrol vehicles; Analyze the vehicle's life cycle in civilian and military applications; Identify and compare the requirements with existing vehicles in the national market; Evaluate the effectiveness of vehicle improvements currently in use or the projection of a new vehicle.

By achieving these objectives, the study aims to contribute to the optimization and development of patrol vehicles that meet the specific demands of policing in rural areas, taking into account both technical and economic aspects. The use of modular technology and adaptation of existing parts will also streamline the maintenance process and reduce costs, thus potentially benefiting the state's public security operations in the long run.

## 2 EXISTING 4X4 VEHICLE FLEET IN THE MARKET

In Brazil, the niche of 4x4 sport utility vehicles, also known as mid-size pickups, has a relatively modest production compared to other segments of the automotive market. Despite the advantage of being able to navigate through challenging terrains such as



mud, sand, flooded areas, damaged roads, and the like, there is limited variety in the available options.

Another important requirement to improve the performance of 4x4 vehicles is the need for robustness in off-road vehicles, which, in addition to civilian commercial use, gain prominence in police operations due to their capability to confront adverse situations in rural areas.

In the practice of off-road driving, the categories typically include cars and pickups, motorcycles, trucks, and UTVs — the latter being the most peculiar, as it is a multitasking vehicle, also known as a Side-by-side, with functioning and structure similar to that of quad bikes.

It is essential to emphasize that for police activities, there are differences and many rules that conceptually distinguish professional competitions from police operations. The patrol vehicle must be equipped with various items and basic requirements to overcome the challenges of the road.

As the existing 4x4 vehicle fleet in the market may not fully meet the specific demands of police operations in rural areas, the study aims to define technical and economic requirements that will ensure better performance and suitability for these tasks. By proposing specific adaptations and utilizing a modular approach, it is hoped that the vehicles will be better equipped to handle the challenges faced in rural policing, while also streamlining maintenance logistics and reducing overall costs.[7]

### 3 EXISTING 4X4 VEHICLE FLEET IN POLICE USE

The national production of military vehicles does not include a specific project and production of 4x4 vehicles for police use. Instead, police institutions acquire vehicles that are originally designed for civilian use and then incorporate some operational requirements (such as weapons, sensors, extra armor, and defense mechanisms) based on their specific demands [3].

As described by PMBA [1], there are many limitations in the 4x4 vehicles sold in Brazil, especially those models used by Public Security Forces in rural policing missions. These are regular commercial vehicles that undergo minor adaptations for use in police missions in areas with difficult access and little or no infrastructure. Often, the users themselves act as mechanics during the missions, attempting to resolve various mechanical problems in the operational environment.

These adversities often arise due to the severe usage in off-road situations, which these superficially adapted vehicles endure during their operation.

It is understood that rural policing presents specific characteristics and demands specific procedures to be adopted by public security organizations to provide prevention and protection services to rural communities. Despite the focus on urban crime and violence due to its scale and dynamics, rural areas receive increased attention in policing activities. Therefore, the need for qualified and well-equipped motorized resources for rural areas cannot be overlooked.

The study aims to address these challenges by proposing technical specifications and adaptations for a family of 4x4 vehicles designed specifically for police use in rural areas of Bahia. By creating vehicles that are better suited for the demands of policing in such environments, the hope is to improve the effectiveness and efficiency of police operations and enhance the safety and security of rural communities. The

use of modular technology and consideration of various operational requirements will be instrumental in achieving these objectives

## 4 THE POLICE VEHICLE

It should be noted that a police vehicle is a type of vehicle used not only by the military but also by the military police and civilian police to transport police officers and/or agents, reach the scene of an incident, transport suspects, patrol an area, or even chase criminals.

These vehicles are adapted according to their area of operation and division. Typically, police vehicles are equipped with sirens, visual warning devices known as "blue lights" (giroflex), depending on their shape, and special markings for civilian identification [3].

According to DAL [3], the average cost of acquiring a 4x4 vehicle currently amounts to R\$ 260,000. On average, the cost of adapting a vehicle for operation with the Public Safety Department is around R\$ 50,000, which includes a holding cell, radio preparation, markings, and accessories.

The vehicles purchased by the police are commercial civilian vehicles, but they undergo modifications, both in terms of performance and visual appearance. They are exactly the same vehicles that any consumer purchases from a dealership. The modifications may include changes in paint, improvements in the bodywork for better resistance and durability, as well as suspension modifications.[7]

Regarding the cost of preventive and corrective maintenance (average) for a civilian 4x4 vehicle compared to the police version used in the interior of the State, the minimum maintenance cost for the police vehicle is R\$ 1,700,00 while a civilian vehicle has an estimated cost of R\$ 950,00 per month.

The lifespan of a police vehicle varies depending on the operational mode, work environment, driver quality, and other factors that can influence the vehicle's depreciation. As a general rule, the higher maintenance costs are a result of wear and the subsequent replacement of tires and filters, with a greater incidence of wear due to the specific nature of rural use.

Considering all the related factors, it is estimated that a police vehicle, classified as severe usage, has a maximum lifespan of 30 months, which may be shorter when the police vehicle is employed in rural environments.

According to information provided by the PMBA in 2023, the vehicle management comprises a total of 939 4x4 traction vehicles allocated outside the city of Salvador/RMS. These vehicles are primarily used in a hybrid operational regime, encompassing both urban and rural employments. Out of this total, 100 of them are predominantly used in rural areas and belong to the Specialized Policing Independent Companies (CIPEs), which, by their nature, carry out activities notably distant from urban environments.

It is worth noting that 70% of the mentioned quantity consists of a leased fleet, with maintenance being the responsibility of the leasing company. The remaining 30% of the PMBA fleet requires each vehicle-holding unit to contract the necessary maintenance.

Based on the data obtained, in 2022, the PMBA added 22 new utility-type vehicles of the GM/Trailblazer model, 10 compact SUVs of the Renault Duster model, and 133

Honda/XRE300 model motorcycles to its fleet. Only the GM/Trailblazer vehicles have partial ballistic protection, primarily intended for urban use.

## 5 FIELD RESEARCH

A field research was conducted with a focus on vehicular operations in tactical, police, and civil activities. The population under investigation consisted of members of the Military Police and Civil Police.

Participants included Military Police officers from specialized units such as the Command of Specialized Policing (CPE), Shock Battalion (BPChq), Special Police Operations Battalion (BOPE), and the Air Group (GRAER) of the Bahia Military Police (PMBA). Additionally, members of the Special Operations Center (COE) of the Bahia Civil Police (PCBA) were also interviewed.

Within the context of the Rio de Janeiro State Military Police (PMERJ), participants included members from the Shock Battalion (BPChq), Special Police Operations Battalion (BOPE), and the Maritime Air Group (GAM). In the Rio de Janeiro Civil Police (PCERJ), officers from the Special Resources Coordination (CORE) were interviewed.

A total of 512 questionnaires were collected using a research instrument titled "Opinion Survey," consisting of nine objective questions and one open-ended question for additional information.

In addition to the questionnaires, 10 interviews were conducted with the managers of these organizations, as well as the commanders and heads of motorized units.

The analysis of the collected data revealed dissatisfaction with the currently used vehicles. This highlights the need for improvement in operational efficiency, directly related to the vehicles in use.

The application of the research showed that while there is a perceived need for greater efficacy and efficiency in operational activities, the respondents did not lean towards the production or assembly of a specific vehicle exclusively for police use, similar to the military fleet with vehicles created exclusively for military purposes.

The respondents leaned towards the need for the use of dual technology in commercial fleets for configuring vehicles. In other words, it is understood that implementing basic operational requirements at the assembly stage is crucial to meet the diverse operational needs, whether in urban or rural areas, as further analyzed in the subsequent section.

## 6 PROPOSALS AND SUGGESTIONS FOR THE STUDY

After analyzing various official technical and administrative documents made available by PMBA and all the referenced materials, it has become evident that there is a need to address operational deficiencies, specifically concerning police vehicles. The natural signs of these deficiencies are reinforced by studies and the presentation of operational requirements to be applied in future acquisitions, such as armored capabilities, off-road functionality, versatility, autonomy, and safety in driving.

In Table 01, a list of suggestions for basic operational requirements [8] for use in police vehicles is outlined.



Table 01 - Basic Operational Requirements for military police vehicles

SUGGESTED OPERATIONAL REQUIREMENTS FOR URBAN/RURAL POLICE 4X4 VEHICLES	
<ul style="list-style-type: none"> <li>- Power: Minimum of 130 hp;</li> <li>- Torque: Minimum 300 Nm;</li> <li>- Number of cylinders: 4 in a row;</li> <li>- Load capacity: Minimum 700 kg;</li> <li>- Fuel storage capacity: minimum 95 liters;</li> <li>- Maximum speed: minimum 120 km/h;</li> <li>- Minimum controlled speed: minimum 4 km/h;</li> <li>- Turning radius (lead to leash): minimum of 7.0 m;</li> <li>- Autonomy: minimum of 750 km;</li> <li>- Traction: 4x4;</li> <li>- Engine: Diesel;</li> <li>- Electric Winch with a minimum capacity of 6 tons;</li> <li>- Hydraulic steering;</li> <li>- Fording without snorkel: minimum 500 mm;</li> <li>- Clearance in relation to the ground: Min. of 230 mm;</li> <li>- Ramp Climb Capacity: minimum of 50%;</li> <li>- Angle of Attack: 50 degrees minimum;</li> <li>- Departure Angle: 30 degrees minimum;</li> <li>- Lateral inclination: minimum of 25%;</li> <li>- Wheelbase: minimum of 2,800 mm;</li> <li>- Total Gross Weight: maximum of 3,300 kg;</li> <li>- Electrical system: voltage- 12 v, with 1x12 v – 70 Ah batteries and with 14 v–20 A alternator;</li> <li>- Capacity: minimum of 5 (five) occupants;</li> <li>- The tread design must be aggressive (off-road/road);</li> <li>- The body must be formed by elements of galvanized steel sheet;</li> <li>- The chassis must be ladder type in high strength steel;</li> <li>- The turning diameter must not exceed 2 times the length of the vehicle;</li> <li>- Installation of the service brake must stop the vehicle, with full load, up to 9.5.0 m, during five successive stops, with the vehicle traveling at 32 km/h when the brake is applied;</li> <li>- Supplied with mudguards on all four wheels;</li> <li>- Two additional projectors with xenon lamps;</li> <li>- Exchange Protector;</li> <li>- Protective character;</li> <li>- tank protector;</li> <li>- Impulse bumper with headlight guard (bush);</li> <li>- Steps on the sides of the vehicle, in round tubular steel with a minimum diameter of 63.5 mm and a minimum thickness of 6.35 mm, painted in black;</li> <li>- The vehicle suspension must allow raising the diagonally opposite wheels 250 mm from the ground without the others leaving the ground;</li> <li>- Body made of steel;</li> <li>- Traffic Plate Support (Front and Rear);</li> <li>- Provided with a digital tachograph for 07 days;</li> <li>- Front part with 02 (two) seats with headrest, and 03 (three) seats in the rear part Black Matte Cadillac;</li> </ul>	<ul style="list-style-type: none"> <li>- Standard removable waterproof hood, with metallic structure with 04 (four) tubular profiles with automotive PVC tarpaulin in Matte Black Cadillac, to cover the vehicle completely in case of bad weather; being easy to remove and completely dismountable;</li> <li>- Provided with a steel plate floor and non-slip floor;</li> <li>- Assembly of an articulated spotlight, in the horizontal and vertical planes, mounted on a mast, on the front right side of the vehicle, so that the passenger seat user can articulate and fix the spotlight in the selected position, from inside the cabin. The fixation device must not allow the searchlight to swing when the vehicle is moving. The spotlight lamp must be xenon;</li> <li>- Acoustic-Signaling Equipment: Electronic siren composed of 01 (one) amplifier of 100 watts of power and a single sound reflector unit, with 4 (four) types of sounds, with a drive installed inside the beacon, with a single horn in the shape of a "U", "Triangular" or similar, generating sound pressure of not less than 120 db at a distance of 01 (one) meter. Control module installed on the vehicle's dashboard, which allows controlling the entire signaling system (acoustic and visual), equipped with a PIC microcontroller, which allows the generation of very high frequency light flashes of 1 flash every 250 ms (cycles of 4 flashes x 1000 ms = 1s), with electronic circuit that manages the current applied to the LEDs, ensuring greater luminous efficiency and useful life of the LEDs;</li> <li>- Have a low voltage sensor system and monitoring of the vehicle's original battery, in the control module, to prevent the signal from functioning when the battery is at minimum capacity, prioritizing engine starting;</li> </ul> <p>Painting: The object must be delivered with the following painting:</p> <p>In standard color and plotting in the identification standards used by the PMBA;</p> <p>UHF Mobile Radio + Transceiver Radio Accessories: UHF 800MHz Mobile Radio Transceiver, Operating Range: 851-869MHZ (RX); 806-824MHZ(TX); 851-870MHZ (Talk-Around); Mode of Operation: Trunking PASSPORT/Conventional; Number of systems/groups: 32 /250; "SCAN" automatic search system; Display with 10 alphanumeric characters; Channel spacing: 25KHz; Operating voltage: 13.6V DC; Antenna impedance: 50Ω; RF power: 15W; Speaker audio: 500mW; Microphone: Handheld Dynamic Microphone (PTT);</p> <p>-The equipment must be equipped with the PASSPORT protocol. Antenna Specifications (for all vehicles): The antenna will have to be magnetic base, 4db and 6.5 dbi.</p>

SOURCE: BOPE/PMBA, 2022.

## CONCLUSION

The discussion about the appropriate vehicle for operational activities in urban and rural areas is an intriguing topic, and it is believed that it can be addressed by investing in Basic Operational Requirements (BORs) [8] and directing research towards the development of a dual technology, as presented in Table 01. This technology should be able to address operational shortcomings, especially when

used in rural environments, where they are more demanding compared to urban areas.

As a result, a proposal was formulated to incorporate BORs [8] into the acquired vehicles, as shown in Table 01. These BORs[8] were based on field research, which indicated a trend towards integrating Operational Requirements into existing commercial vehicles rather than developing a specific 4x4 vehicle for police use. Factors such as ergonomics, performance, and interior space for users were considered, aiming to fulfill various police missions.

Consequently, addressing the problem of defining the technical and economic requirements to ensure the desired performance of these vehicles, which should assist in the acquisition processes or future development of vehicles for this purpose, it was found to be viable to have a dual product. This means customizing military vehicles for rural police use.

The study emphasizes the importance of a dual product, even though it was not explicitly observed in the field research. Professional experience leads to the need for designing a specific vehicle for police activities, as the deficiencies mentioned in the research cannot be ignored.

A vehicle with well-designed BORs[8] can provide operators with the reliability and durability required for operational use, enhancing agility and off-road performance. This redefines its role as a perfectly adapted tactical vehicle for the expected needs, resulting in cost savings for preventive and corrective maintenance.

## REFERENCES

- [1] POLÍCIA MILITAR DO ESTADO DA BAHIA. **E-book projects**; elaboration and management protocol. Salvador: Departamento de Planejamento (DEPLAN); Centro Corporativo de Projetos, 2021.
- [2] BASTOS, Expedito Carlos Stephani. **Agrale Marruá ¾ ton. 4x4, one more member of the family**. MG: UFJF. defesa@ecsbdefesa.com.br Accessed in June 2022.
- [3] POLÍCIA MILITAR DO ESTADO DA BAHIA **Rural tips for driving a 4x4 police vehicle**. Vitória da Conquista: 92ª Cia Independente/PMBA Sudoeste, 2020.
- [4] \_\_\_\_\_. **Operational report**. Salvador: Diretoria de Apoio Logístico (DAL), 2022.
- [5] HENRIQUES, Fabrício. MIGUEL, Paulo Augusto Cauchick. **Adoption of modularity in product and production in the automotive industry**: a comparative analysis in vehicle projects with the participation of Brazilian engineering. Gestão da produção, vol. 24, n. 1, pp. 161-177, 2017.
- [6] DAWOOD, M. Sheikh. **Armored modular and non-modular vehicle survey**. International Journal of Engineering and Advanced Technology, vol. 8, issue 3, Feb. 2019.
- [7] RUE, Timothy J. **Modular vehicle design concept**. Master's thesis. Blacksburg: Virginia Polytechnic Institute and State University, 2014.
- [8] MINISTRY OF THE ARMY. General Staff. **Directive 07-EME: basic operational requirements - 08/95: non-specialized transport vehicle, 3/4 ton, 4x4, category 1 VTNE**. EME, 1995.