Maximizing Tactical Success: The Impact of the Mechanized Anti-Tank Company in a Coordinated Attack Assessed Through Constructive Simulation

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Keywords: Constructive Simulation, Mechanized Antitank Company, Simulation-Based Training, Sword Combater, Antitank Defense.

Abstract: In a global scenario where precision and effectiveness in military operations are essential for success, constructive simulation emerges as an indispensable tool for preparing modern armed forces. This study aims to assess the advantages of employing the Mechanized Antitank Company in support of a Mechanized Infantry Brigade during a coordinated attack. Using the constructive simulation software Sword COMBATER, two identical tactical scenarios were modeled, with the only difference being the inclusion or exclusion of the Antitank Company. The results showed that the presence of the Mechanized Antitank Company increased enemy armored vehicle losses by 21.83% (Student's t-test, $p = 0.0139$, Cohen's $d = 1.51$), demonstrating its significant impact on antitank defense and the neutralization of enemy armored vehicles. Based on a detailed analysis of the simulation and a literature review, the study offers proposals for the optimized employment of this company in coordinated attacks, contributing decisively to the success of Mechanized Infantry Brigade operations and supporting command and staff actions.

1 INTRODUCTION

The Fourth Industrial Revolution, with a focus on automation and technologies such as artificial intelligence and the internet of things, has brought advancements in simulation, enabling the creation of realistic virtual environments that reduce costs and enhance training. The armed forces have widely adopted these systems to intensify the preparation of their troops in environments that simulate war scenarios, improving the tactical and strategic capabilities of military personnel. An example is the U.S. Marines' "war lab," dedicated to the development of war games (Almeida *et al*., 2023).

At the beginning of the century, Mary Kaldor (2013) already speculated that modern conflicts would arise due to reasons based on political and cultural identities that predate the formation of states. Henry Kissinger, the renowned American diplomat, made a comment during the World Economic Forum in Davos in 2022 about the new global scenario created by the conflicts between Russia and Ukraine, highlighting that, given the nature of these conflicts, which exhibited the characteristics discussed by Kaldor, Brasil's rise would have to be integrated into a broader international system (Bester, 2022).

The Brasilian Army, aligned with the National Defence Policy and Strategy, has undergone a vigorous transformation process to meet the challenges of the 21st century (Brasil, 2022) and remain in a state of readiness. This transformation includes the operationalization of Mechanized Infantry Brigades (Nakashima, 2021), equipped with modern Guarani Medium Wheeled Armored Personnel Carriers (Brasil, 2021, 2022).

The 11th Mechanized Infantry Brigade, for example, is designed for operational flexibility, capable of conducting offensive and defensive operations in diverse terrains and across the full

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Vieira da Silva, J. P. M., Pochmann, P. G. C. and Neves, E. B.
Maximizing Tactical Success: The Impact of the Mechanized Anti-Tank Company in a Coordinated Attack Assessed Through Constructive Simulation.
DOI: 10.5220/0013461600003970
In *Proceedings of the 15th International Conference on Simulation and Modeling Methodologies, Technologies and Applications (SIMULTECH 2025)*, pages 234-241
ISBN: 978-989-758-759-7; ISSN: 2184-2841

spectrum of conflicts. In offensive operations, the anti-tank defence plays a crucial role, neutralizing or destroying enemy armored vehicles. The mechanized anti-tank company commander advises the brigade commander on this matter, who ultimately decides on the company's employment (Brasil, 2023).

Due to its characteristics, organization, and military equipment, the Mechanized Infantry Brigade has the effective capacity to participate in operations across the full spectrum of conflicts, making it an important and up-to-date combat force of the Brasilian Army, as previously discussed (Brasil, 2021).

Currently, the Mechanized Infantry Brigade is expected to have the organizational structure as shown in Figure 1 (*PE* means Military Police).

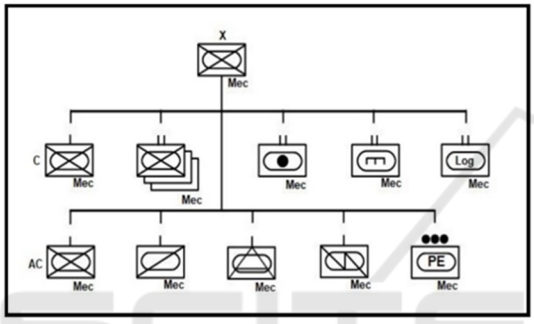

Figure 1: Organizational structure of the Mechanized Infantry Brigade.

The anti-tank (*AC* means anti-tank) company of the Mechanized Infantry Brigade, according to the current Doctrine Manual, is organized as shown in Figure 2, consisting of a Command and Support Platoon, two anti-tank Platoons (equipped with anti-tank combat vehicles armed with a 105 mm cannon or higher), and two anti-tank Missile Platoons:

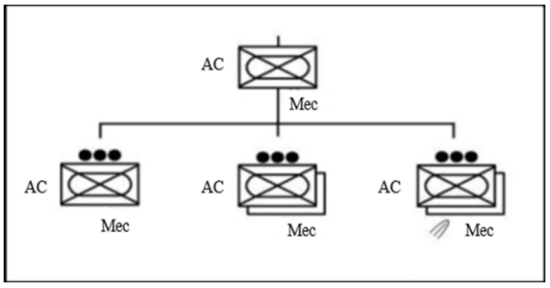

Figure 2: Organizational structure of the Mechanized Anti-Tank Company.

According to the initiation guideline issued in 2024, the 1st Mechanized Anti-Tank Company, subordinated to the 11th Mechanized Infantry Brigade, will have four anti-tank missile platoons (two of which will replace the anti-tank platoons), utilizing the Spike LR2 anti-tank missile system from the Israeli company Rafael Advanced Defence Systems, which has been adopted by the Brasilian Army (but has not yet been delivered due to issues related to the current armed conflict in which Israel is involved), or the future MSS 1.2 AC from SIATT, which is in the final stages of the homologation and adoption process, based on the Campaign Manual EB70-MC-10.323 Anti-Tank Company, Experimental Edition, 2022 (Bastos Junior, 2024).

At the time he was still the commander of the U.S. Army in Europe, General Ben Hodges oversaw the expansion of U.S. military cooperation with Ukraine after 2014, when the Russian Federation took Crimea, a region that naturally includes urbanized areas, and supported an armed insurgency in eastern Ukraine that claimed over 13,000 lives. Since then, the United States has provided $1.5 billion in security assistance, including, among other Military Equipment, anti-tank missiles. In other words, it is evident that the provision of anti-tank capabilities is essential for the success of military operations in the current context (Kozera *et al*., 2020).

In the current conflict between the Russian Federation and Ukraine, for example, the Russians have been able to observe the vulnerability of their armored vehicles against Ukrainian anti-tank weaponry, necessitating that their armored units be regularly escorted by other forces, which also carry anti-tank missiles (Van Creveld, 2023).

Since the beginning of the mentioned conflict, Ukraine has received approximately 5,500 anti-tank missiles solely from the United States, which are even more effective against Russian armored vehicles, as the turrets of these vehicles offer less protection compared to the turrets of American armored vehicles, for instance (Mandeiro, 2022).

In an interview for the Partnership for Conflict, Crime, and Security Research, Mary Kaldor stated that the leaders of the North Atlantic Treaty Organization (NATO), the G7 (comprising Germany, Canada, the United States, France, Italy, Japan, and the United Kingdom), and the European Union are right to consider providing anti-tank weaponry to Ukraine, given the belligerence with the Russian Federation. Once again, it is demonstrated that it is essential for any army to possess anti-tank Military Equipment in the battles of the 21st century (McNeil, 2022).

Thus, the war in Ukraine provides vivid testimony to the effectiveness and high rate of use of modern precision anti-tank weapons. General Mark Milley, Chairman of the U.S. Joint Chiefs of Staff, stated that

approximately 60,000 anti-tank weapons have been delivered to Kyiv, which played a significant role in disrupting Moscow's initial offensive and forced the Russian leadership to scale back its expansionist objectives (Mahnken, 2022).

To keep the Mechanized Infantry Brigade updated and ready to face the threats of modern conflicts, Nakashima (2021) states that, in a comparative study with the Stryker Brigade Combat Team (SBCT), within the scope of the Guarani Strategic Program, the development of medium and light wheeled combat vehicles is underway. In the future, these vehicles could provide the Mechanized Infantry Brigade with anti-tank defence capabilities, analogous to those of the SBCT.

The Spike LR2 weapon system has effectively fought against Russian tanks and armored vehicles. Ukrainian soldiers utilize excellent cover and employ drones to monitor access routes. When Russian tanks and armored vehicles approach, the Spike LR2 missile is launched to neutralize or destroy them (Linganna, 2022).

Thus, the aim is to use the results of this study to address the gaps in knowledge identified both in the experimental nature of the three campaign manuals that establish the doctrine for mechanized infantry troops of the Brasilian Army and, for example, in the recent acquisition and integration of the Spike LR2 Anti-Tank Missile weapon system, which, as previously noted, will be part of the arsenal of the Mechanized Anti-Tank Company, contributing to the goal of maintaining a state of constant doctrinal updating for the Army (Brasil, 2022).

2 METHODOLOGY

2.1 Simulation Modelling

The experimentation used in this work is Constructive Simulation, utilizing the COMBATER system, a simulation software developed specifically for the Brasilian Army based on the French software Sword, by the company RustCon. COMBATER can be used in exercises at the Unit, Brigade, and Division levels. It allows for the simulation of combat operations in various operational environments across the national territory, in accordance with the military doctrine of the Brasilian Army (Brasil, 2018).

The following simulation was planned and conducted by these authors, applying the Tactical Commander Situation Examination in the context of an offensive operation, using protocols and methodologies like those employed by Almeida *et al*. in an article published in 2023, which has already been duly published, approved, and recognized internationally.

At the tactical level, the Brazilian Army employs the COMBATER software (hardware version 6.19 of the French Sword software) in training exercises categorized as "War Games"; the software uses an automatic simulation process, that is, it makes its tactical decisions according to the extensive databases and programming available to it. In these simulations of operations and combat, the combat functions of Command and Control, Movement and Manoeuvre, Intelligence, Fires, Logistics, and Protection are integrated and trained using this technological apparatus. The Command and General Staff College (Escola de Comando e Estado-Maior – ECEME) and the Officers' Improvement School (Escola de Aperfeiçoamento de Oficiais – EsAO), for example, conduct annual war games such as Operation ONIX, in which simulations of offensive and defensive operations involving army divisions and brigades are carried out (Almeida *et al*., 2023).

Based on the experience of Tolk, 2012, the simulation was based on the operational vision (what needs to be modeled: critical elements of combat, based on anti-tank units in a coordinated attack), on the conceptual vision (how to model combat: use of the aforementioned software, comparing results between two antagonist belligerents, using or not troops dedicated to anti-tank combat); and the technical vision (how to conduct the simulation: theater of operations, combat environment and scenario, collection and analysis of results and data, and strategic validation).

2.1.1 Coordinated Attack

In the development of this work, a coordinated attack was simulated between BLUE Country and RED Country, aimed at attacking to conquer and maintain positions held by RED, which had established defensive positions in the state of Santa Catarina (vectorized topographic map XANXERÊ-SE). The Planning Directive from the Commander of the BLUE Mechanized Infantry Brigade is to inflict maximum casualties on the enemy's armored units while securing the objective. At the end of the attack, the BLUE Mechanized Infantry Brigade must be able to hold the terrain to support the advance of friendly troops and receive subsequent tactical missions.

2.1.2 Theatre of Operations

The area in which the simulation takes place features firm soil and grassy vegetation, creating wide open

spaces, along with small-scale plantations that do not pose obstacles for the troops involved. Most roads are paved and in good condition for travel. The bridges are classified as high-grade, compatible with all armored vehicles and other vehicles involved in the operation. Watercourses and small reservoirs in the region do not present obstacles for the troops. However, there are certain areas where the terrain has an incline exceeding 60%, which restricts foot troop movement and prevents the maneuvering of armored vehicles and other vehicles involved in the operation.

2.1.3 Composition of Means

The BLUE and RED troops employed in the constructive simulation, possessing the same nature, were organized as per the following table:

Table 1: BLUE and RED Composition of Means.

BLUE FORCES	RED FORCES
A Mechanized Infantry Brigade composed of three Mechanized Infantry Battalions	A Mechanized Cavalry Regiment composed of three Mechanized Cavalry Squadrons
A mechanized field artillery group (155mm self-propelled)	
A Mechanized Combat Engineering Battalion	
A Mechanized Logistics Battalion	
A Mechanized Cavalry Squadron	A Mechanized Command and Support Squadron
A Mechanized Communications Company	
A Mechanized Air Defence Battery	
A Mechanized Anti-Tank Company (present in only one of the simulations)	

2.1.4 Courses of Action (CoA)

Two Courses of Action were established, set within the same operational context of the constructive simulation. They are distinct because only in the first simulation did the Mechanized Anti-Tank Company get employed, as shown in Figures 3 and 4.

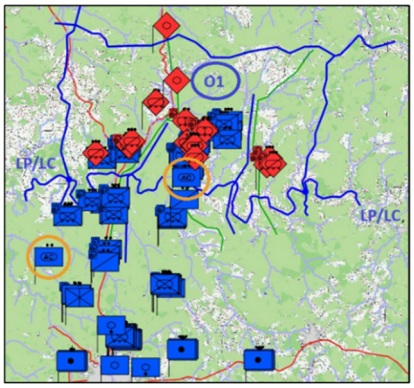

Figure 3: Modelling of the simulation for Courses of Action No. 1.

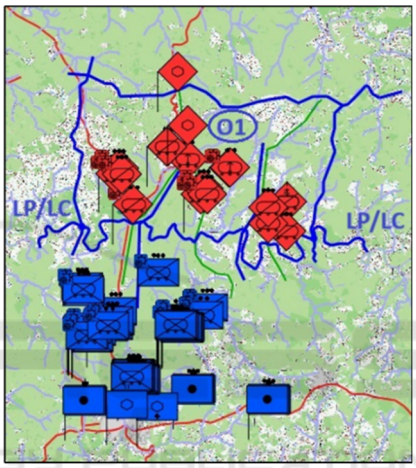

Figure 4: Modeling of the simulation for Courss of Action No. 2.

2.2 Software COMBATER

The SWORD platform is a constructive simulation system developed by the French company MASA Group. SWORD has the capability to perform constructive simulation up to the Brigade level and can exceptionally be used at the Army Division level. This system allows training in two ways: one geared towards self-training, Command Post training, and cooperative exercises; the other aimed at visualizing ground operations, presenting analysis of Courses of Action and supporting decision-making (Cunha, 2011).

In 2013, the Land Operations Command acquired SWORD and, after significant customization with elements of the Brasilian Army, such as troops, tactics, and equipment, it began to be called COMBATER, which is its major differentiator from other non-customized systems. In this context, the French software started to be used in the training of

strategically employed Brigades and, more recently, by the Brasilian Army's Readiness Forces (Menegaz, 2020).

Furthermore, according to Cunha (2011), using the French system MASA SWORD as an example, the possibilities of Constructive Simulation in staff training are numerous. It provides individual training, cooperative exercises, and training for the tactical commander's situational assessment, allowing interaction between the commander and their staff. Additionally, it includes models for disasters, fires, floods, and chemical, biological, and nuclear contamination.

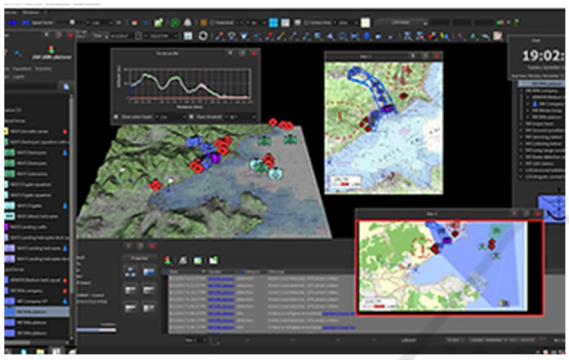

Figure 5: Software MASA Sword.

2.3 Indicators Used to Examine the Courses of Action

To analyze and compare the different courses of action, six indicators were selected that represent the component "enemy armored vehicle casualties," according to the Planning Directive of the Commander of the Blue Mechanized Infantry Brigade, whose goal was to maximize casualties among enemy armored troops. The selection of these indicators is justified by their tactical relevance and direct impact on the success of the mission.

The focus on armored casualties is crucial because, in a mechanized combat scenario, neutralizing enemy armored vehicles not only reduces the offensive capability of the adversary but also ensures greater mobility and security for one's own troops. Enemy armored vehicles represent one of the greatest threats to mechanized combat forces, both due to their firepower and their resilience on the battlefield (Brasil, 2021).

Moreover, anti-tank defense plays a central role in the military doctrine of offensive operations, as outlined in the Campaign Manual for the Mechanized Infantry Brigade (2021), which emphasizes the importance of covering the likely access routes of enemy armored vehicles. Therefore, the capability of a Mechanized Anti-Tank Company to inflict substantial casualties on enemy armored vehicles is crucial for mission success, directly contributing to the neutralization of these threats and the protection of the involved troops (Brasil, 2021).

Thus, the six indicators were carefully selected based on their relevance to the overall mission of the Mechanized Infantry Brigade and the tactical effectiveness of the anti-tank company. They represent the company's ability to enhance the combat power and protection of the brigade, allowing for a more effective and secure action against enemy armored forces, which, if not neutralized, could jeopardize the success of the offensive operation and subsequent phases of the mission.

2.4 Data Analysis

In order to verify the gains resulting from the employment of the Mechanized Anti-Tank Company, the data from the simulations in the COMBATER System were compared and discussed. The raw data were converted into percentages to facilitate understanding, based on the maximum values of each indicator. To accurately assess the differences between the courses of action, the p-value was checked, and the effect size was evaluated using Cohen's d statistic. All tests were performed using Jamovi software, and the significance level was set at 95% (alpha = 0.05).

3 RESULTS

According to Table 2 – Analysis of Enemy Indicators, it can be seen that in Course of Action No. 1 (with the deployment of the Mechanized Anti-Tank Company), there were, on average, about 16% more enemy casualties concerning Light Armored Vehicles Command Post and Reconnaissance vehicles, and Medium Armored Vehicles Reconnaissance Cascavel.

Regarding the Armored Personnel Carriers Urutu Mortar Heavy and Light Armored Vehicles Mortar Medium, an even higher casualty rate was observed (an average of 37%), especially concerning the Urutu Mortar Heavy (50%).

As for the Armored Personnel Carriers Urutu, the main enemy armored combat material, there were at least approximately 10% more casualties.

The BLUE and RED troops employed in the constructive simulation, possessing the same nature, were organized as per the following table:

Table 2: Analysis of Enemy Indicators Data.

ARMORED VEHICLES	CASUALTIES		DIFFERENCE (%)
	CoA No. 1 (%)	CoA No. 2 (%)	
Command Post	67	50	17
Reconnaissance	63	48	15
Reconnaissance Cascavel	61	45	16
Urutu Mortar Heavy	100	50	50
Urutu Mortar Medium	67	44	23
Urutu	55	45	10
Average	68,83	47	21,83
p value	0,0139		
Effect Size (Cohen's d)	1,51		

Regarding the statistical analysis of the data, with a p-value of 0.0139, there is a significant difference in the percentages of losses between CoA No. 1 and No. 2, with a confidence level of 95%, since the p-value is less than 0.05.

For the value of Cohen's d, which is 1.51, there is also an indication of a considerable effect size. Thus, the difference in percentages of losses between CoA No. 1 and No. 2 is not only statistically significant but also substantial in practicality.

4 DISCUSSIONS

The results of the simulation conducted, considering the employment or not of the Mechanized Anti-Tank Company, demonstrated a significant increase in losses inflicted on enemy armored vehicles through the use of the Mechanized Anti-Tank Company, with an approximate increase of 22% in enemy armored vehicle losses. Such data indicates that the integration of anti-tank capabilities and the corresponding added possibilities in combat are critical differentiators for the Mechanized Infantry Brigade.

The p-value of 0.0139 and an effect size in Cohen's d of 1.51 not only indicate statistically significant differences between the two courses of action but also highlight the practical importance of the Mechanized Anti-Tank Company in offensive operations. Thus, the need for ongoing investment in the evolution and development of anti-tank doctrine and technology is reinforced, aiming to enhance the operational capability of the Brazilian Army.

The data analysis suggests that the implementation of anti-tank companies is directly aligned with the demands of contemporary conflicts, in which the neutralization of armored vehicles has become decisive. The simulation demonstrated the significant impact of these companies on increasing enemy armored vehicle casualties, reflecting the need to integrate these capabilities into real strategic planning. This alignment between the effectiveness demonstrated by the simulation and the demands of the modern battlefield, as evidenced in the conflict between Ukraine and Russia, highlights the importance for the Army to continue evolving its anti-tank tactics and technologies, thereby ensuring readiness to confront future threats and protect national sovereignty.

In your work, Almeida (2023) discusses the use of the COMBATER software as a tool for tactical training and operational research within the Brazilian Army. The study highlights the software's ability to create realistic scenarios and analyze different courses of action, ultimately contributing to the decision-making process and tactical learning of Brazilian Army captains.

While our research focuses on the specific application of the Mechanized Anti-Tank Company, Almeida (2023) explores the broader application of constructive simulation for tactical training and operational research. Both studies, however, converge on the recognition of the importance and effectiveness of simulation in the military context. Almeida's findings validate the relevance of our research by demonstrating the effectiveness of constructive simulation in another military context, reinforcing the potential of this approach for the development and improvement of military tactics and technologies.

Furthermore, Almeida (2023) highlights the potential of COMBATER for operational research, which could be explored in future research to analyze the performance of Mechanized Anti-Tank Company in more complex scenarios and with a broader range of variables. The integration of different simulation tools and approaches could provide a more comprehensive and robust analysis of the operational capabilities of new military technologies, contributing to more effective decision-making in the acquisition and development of these technologies.

Finally, both studies highlight the importance of investing in the development and application of simulation tools in the military context. The contemporary operational environment demands

constant evolution and adaptation, and simulation proves to be an effective tool for testing new technologies, training military personnel, and developing doctrines and tactics that meet the challenges of modern warfare.

The results of the simulation show that the presence of the Mechanized Anti-Tank Company can drastically alter the course of a military operation, directly impacting command decisions. Continuous training and preparation of these units become crucial not only for maintaining readiness but also for adjusting logistical infrastructures and doctrine. Based on the simulated scenarios, it is possible to develop more robust strategies tailored to modern challenges, ensuring that the Mechanized Infantry Brigade has the necessary tools to conduct successful operations in any operational environment.

5 CONCLUSIONS

The results presented in this work emphasize the importance of the Mechanized Anti-Tank Company as a crucial component for the Mechanized Infantry Brigade. Statistical and practical evidence further reinforces the need for continuous investment and development of these capabilities to ensure a constant state of readiness in light of the challenges posed by armed conflicts in the 21st century.

The Brazilian Army, by investing in enhancing the power of its mechanized infantry brigades through the implementation of mechanized anti-tank companies, clearly demonstrates its commitment to modernization and effectiveness in contemporary combat. The simulation results highlight that the addition of this unit not only increases its combat power but also provides protection to the troops and, secondly, ensures the safety of the population in conflict areas, which are increasingly fought in areas inhabited by civilians.

As seen in the war between Ukraine and Russia, the updating of combat doctrine and the application of new technologies make a positive difference in armed conflicts of the 21st century. Therefore, the Brazilian Army should not neglect the training and preparation of its troops, ensuring that its units are equipped and ready to be employed efficiently in a troubled, complex, and dynamic operational environment.

As a proposal for the expansion of this study, it is recommended to conduct new simulations involving Mechanized Air Defense Units and Engineering Units. The inclusion of air defense companies may reveal the impact of protection against aerial attacks in both offensive and defensive operations, especially in scenarios where the enemy has air superiority. The presence of these units can enhance the resilience of mechanized troops, safeguarding them from aerial threats and increasing their combat power on the ground.

Similarly, the employment of Mechanized Engineering Units would allow for an assessment of the role of these companies in removing obstacles, such as mines and destroyed bridges, ensuring the mobility of the Army and the continuity of operations. These expansions would provide a broader view of the effectiveness of mechanized brigades in a modern combat scenario, considering the importance of synergy among different military capabilities in the success of operations.

Finally, it is important to consider the development of future studies on determining the ideal dosage and the appropriate level of anti-tank combat power for each type of troops in combat, considering the nature of the threat to be faced. Such research could explore other operational scenarios, based on factors such as the type of enemy armored forces, the capacity of use and maneuver of anti-tank troops, and the integration with other combat elements, such as indirect fire support and electronic warfare. In addition, simulations and tactical exercises could be used to verify the effectiveness of different weaponry and troop organization concepts, allowing for a more precise adjustment of anti-tank capabilities to the demands of the modern battlefield.

The continuous development of a powerful, modern, and flexible Army is essential for regional and intercontinental deterrence and the guarantee of national sovereignty. Consequently, this must always be a priority for those who decide on the course of defense, as only in this way can Brasil ensure not only its territorial integrity but also significantly contribute to regional and global peace and stability.

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