

COORDINATION, MILITARY SUPPORT, AND INFRASTRUCTURE IN BORDER EDUCATION: THE MODERATING ROLE OF STUDENT MOTIVATION

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Citation (APA 7th): Firdaus, N., & Karimah, K. (2025). Coordination, Military Support, and Infrastructure in Border Education: The Moderating Role of Student Motivation. *Jurnal Minds: Manajemen Ide Dan Inspirasi*, 12(2), 731–744. <https://doi.org/10.24252/minds.v12i2.61040>

Submitted: 23 August 2025

Revised: 22 & 28 December 2025

Accepted: 31 December 2025

Published: 31 December 2025



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ABSTRACT: Positioned within management science on coordination and resource deployment in public service delivery, this study examines learning effectiveness in frontier border-region schools facing geographic isolation and chronic resource constraints. The study contributes by theorizing and testing an integrated coordination–capacity model that links communication management, the Indonesian National Armed Forces (TNI) educational support as institutional capacity, educational infrastructure, and student motivation as joint determinants of learning effectiveness in border education. Survey data were collected from junior and senior high school students in the Tanimbar Islands, Maluku, and analyzed using PLS-SEM. Results show positive effects of communication management, TNI support, and infrastructure on learning effectiveness, while student motivation both strengthens learning outcomes directly and amplifies these managerial and institutional effects. The findings imply that equity-oriented border education policy should prioritize cross-actor coordination and sustained motivational supports alongside basic infrastructure investment.

Keywords: Communication Management; Military Educational; Educational Infrastructure; Student Motivation; Learning Effectiveness

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DOI: <https://doi.org/10.24252/minds.v12i2.61040>

ISSN-E: 2597-6990

ISSN-P: 2442-4951

<http://journal.uin-alauddin.ac.id/index.php/minds>

Publisher: Management Department, Universitas Islam Negeri Alauddin Makassar, Indonesia

INTRODUCTION

Education is one of the fundamental factors in developing high-quality, competitive human resources (HR) with a strong sense of national identity (Barreiros dos Santos et al., 2019). Ensuring equitable improvements in education quality has become a priority agenda in national development (Tung et al., 2009). However, there remains a significant gap between the quality of education in urban areas and that in border regions (Ščavničar, 2023). Limited availability of teachers, inadequate educational facilities, and challenging geographical conditions serve as major obstacles to effective learning in border areas. These conditions result in low academic achievement among students and restricted access to quality education.

One region facing such challenges is the Tanimbar Islands in Maluku Province, which serve as a strategic border area in the southern part of Indonesia. This region falls into the 3T category (frontier, outermost, and underdeveloped areas), where access to transportation, infrastructure, and educational facilities remains limited. Geographical challenges contribute to the uneven distribution of teachers and insufficient learning resources, thereby hindering the effectiveness of the learning process (Basirun, 2012). Consequently, cross-sectoral support is urgently needed to ensure that education in border regions can proceed effectively. In 2024, Maluku continued to face challenges in secondary school participation, as reflected in a junior high school NER of 79.72% and a senior high school NER of 69.61%, indicating that a substantial proportion of school-age children were not enrolled at these levels.

Within this context, the educational role of the Indonesian National Armed Forces (TNI) has become increasingly relevant. Beyond its primary mandate of safeguarding national sovereignty, the TNI conducts Military Operations Other Than War (MOOTW), which include educational programs such as TNI Teaching or TNI Educating. These initiatives aim to fill gaps in teacher shortages, provide tutoring, and instill values of discipline and nationalism in students (Saiman et al., 2025). The involvement of the TNI demonstrates a unique synergy between defense and human development, offering a model of collaboration that directly addresses educational challenges in border areas.

Equally important is the role of communication management in supporting the learning process (Ziberi & Syla, 2025). Effective communication among teachers, students, parents, and schools fosters a conducive learning environment, minimizes miscommunication, and strengthens coordination (Basirun, 2012). In border regions, however, communication is often complicated by limited technological infrastructure and socio-cultural diversity (Alnaqbi, 2020; Boye & Agyei, 2025). As a result, communication management becomes a critical factor that can either facilitate or hinder the success of educational programs.

In addition, educational infrastructure remains a fundamental determinant of learning effectiveness (Fletcher, 1990). Prior studies have consistently demonstrated that adequate facilities—such as classrooms, libraries, laboratories, and digital access—positively influence the quality of education (Jewarut et al., 2024). Yet, infrastructure in border areas remains underdeveloped, further exacerbating disparities in learning outcomes. Without proper facilities, even well-trained teachers and motivated students struggle to achieve optimal learning results.

Another crucial factor is student motivation, which represents an internal determinant of learning effectiveness (Boye & Agyei, 2025; Phelps et al., 1991). According to Self-Determination Theory (Deci & Ryan, 2000), intrinsic and extrinsic motivation are central drivers of student engagement and achievement. Students with high motivation are more adaptive and resilient, while those with low motivation are vulnerable to disengagement, particularly in disadvantaged contexts. Motivation, therefore, plays a critical role not only as a direct influence on learning but also as a moderating factor that strengthens or weakens the effects of external conditions (Gao, 2025). Yet, research investigating the moderating role of student motivation in border education remains scarce, highlighting an important research gap.

Existing literature on border education has predominantly focused on material constraints such as teacher distribution and infrastructure (Supriyadi, 2020; Nurlina, 2020). While valuable, such studies have often neglected broader systemic and relational factors. For example, studies on the TNI's involvement in education largely emphasize its role in character building and nationalism (Prakoso, 2019), with limited examination of its direct influence on learning effectiveness. Similarly, research on communication management has generally concentrated on teacher–student interactions without considering it as part of a wider institutional and

community-based system (Effendy, 2018). This narrow focus leaves important dimensions of border education unexplored.

In addition, prior research has often positioned learning motivation as an independent or mediating variable influencing academic achievement (Deci & Ryan, 2000; Schunk et al., 2014). Yet, in the unique context of border education, motivation may function more effectively as a moderating variable—one that amplifies or diminishes the impact of external factors such as communication management, the educational role of the TNI, and infrastructure (Hruzevskyi, 2023; Lancu et al., 2017). The absence of studies adopting this perspective further highlights the novelty and significance of the present research.

This study, therefore, seeks to address these gaps by integrating three key external factors—communication management, the educational role of the TNI, and educational infrastructure—into a comprehensive model of learning effectiveness in border regions. Crucially, it positions student motivation as a moderating variable, offering a fresh perspective on how internal and external factors interact in shaping educational outcomes. The study employs a case study in the Tanimbar Islands, Maluku, to provide empirical insights into these dynamics.

By doing so, the study contributes theoretically to the literature on border education, expanding understanding beyond the traditional focus on infrastructure and teacher distribution. It also provides practical contributions by generating policy-relevant recommendations for local governments, educational institutions, and the TNI. Specifically, it underscores the importance of strengthening communication systems, leveraging the TNI's educational role, improving infrastructure, and fostering student motivation to enhance learning effectiveness in disadvantaged, frontier, and outermost (3T) regions.

Learning effectiveness in border areas is shaped by both external and internal factors. Existing studies have examined these factors in isolation, leaving a fragmented understanding of how they interact. By offering an integrated approach, this research provides a more holistic framework for understanding and improving education in border regions. It highlights the critical role of student motivation as a moderating factor and emphasizes the unique contributions of the TNI in bridging educational gaps. Ultimately, the study aims to enrich both academic literature and practical policymaking in the pursuit of equitable and effective education in Indonesia's borderlands.

THEORETICAL REVIEW

Educational Management in Border Regions as a Management Science Problem

Border and frontier regions present persistent constraints for public service delivery, including limited administrative reach, geographic isolation, and uneven resource distribution (Haile & Mekonnen, 2024). In this setting, learning effectiveness can be analyzed not only as an educational outcome but also as a performance outcome of management processes—coordination, governance arrangements, and resource deployment—within a constrained service system (Boye & Agyei, 2025). This framing aligns the study with management science literature on how organizations achieve performance under environmental constraints through coordination capability and institutional arrangements (Amirlu, 2025; Lepinoy et al., 2022; Noble, 2017).

Communication Management and Learning Effectiveness

Communication management refers to managerial processes that enable planning, coordination, and control through structured information flows across actors and recipients (Phelps et al., 1991). In educational organizations, effective communication is commonly characterized by clarity of information, transparency, feedback mechanisms, and message consistency, because these features reduce ambiguity, align expectations, and support routine execution (Fletcher, 1990; Gaikwad & Choudhary, 2024; Newton & Ellis, 2005; Thain et al., 2008) (Clampitt, 2016; Hargie, 2011; Salamondra, 2021). Prior education-management studies also indicate that communication quality influences learning processes by shaping classroom climate, instructional alignment, and stakeholder cooperation (Tung et al., 2009). In constrained

settings, communication management can function as a “coordination substitute” when physical resources and supervisory capacity are limited, making it particularly salient for frontier schools (Hentea et al., 2003; Thain et al., 2008).

H1: In border-region schooling, stronger communication management increases learning effectiveness because it stabilizes implementation and improves alignment between learning expectations and actual learning activities.

The Educational Role of the Military (TNI) as Cross-Actor Governance Capacity

In frontier areas, education delivery often requires cross-actor collaboration to maintain service continuity. Collaborative governance theory explains how outcomes can improve when public agencies and other actors coordinate through shared operational goals, clear roles, and practical implementation support (Ansell & Gash, 2007). Within border contexts, the educational role of the TNI can be conceptualized as a governance-capacity mechanism that supports program continuity, discipline-based routines, and supplementary mentoring—functions that may be difficult to sustain through conventional administrative channels alone. Existing studies in Indonesia highlight TNI involvement in educational support and character-building programs, suggesting potential links to student discipline and engagement (Prakoso, 2019). However, empirical modeling that positions TNI support as a governance/input factor affecting learning effectiveness—especially in border regions—remains limited.

H2: In border-region schooling, TNI educational support contributes to learning effectiveness through implementation reliability and reinforcement of structured learning routines.

Educational Infrastructure as an Enabling Resource

Infrastructure provides the physical and material conditions that enable learning routines to be executed consistently and reliably. From a management and resource-based perspective, infrastructure can be viewed as an enabling asset, as it enhances the productivity of teaching and learning processes and reduces operational bottlenecks (Barney, 1991; Grant, 1991). In frontier schools, infrastructure constraints are often binding (including space, learning tools, and basic facilities), so incremental improvements may yield measurable gains in learning effectiveness when they directly support routine execution. Prior studies in the Indonesian context similarly emphasize that infrastructure adequacy is associated with better learning processes and outcomes (Supriyadi, 2020).

H3: In border-region schooling, stronger infrastructure conditions improve learning effectiveness because they raise the feasibility and stability of instructional routines .

Student Motivation as a Direct Driver and Moderating Boundary Condition

Motivation theories provide a basis for modeling student motivation as both an independent predictor of learning outcomes and as a boundary condition that strengthens the influence of external supports (Iancu et al., 2017). Self-Determination Theory explains how motivational quality relates to sustained engagement and persistence (Ryan & Deci, 2000). Expectancy–value frameworks emphasize that beliefs about success and task value shape effort and achievement-related choices (Eccles & Wigfield, 2002). Expectancy theory similarly links effort and performance to expectations regarding outcomes (Vroom, 1964). In frontier contexts, where external support may be uneven and learning conditions fluctuate, motivation can determine whether students translate available support (such as communication routines, governance support, and infrastructure) into consistent learning behavior. This provides a theoretical rationale for positioning motivation as a moderator:

H4: Stronger motivation should amplify the effectiveness of management and resource inputs.

H5: Student motivation has a positive influence on learning effectiveness.

H6: Student motivation strengthens the effects of communication management, TNI educational support, and infrastructure on learning effectiveness by increasing the conversion of external inputs into sustained learning engagement.

Synthesis, Research Gap, and Parsimonious Conceptual Model

Existing research supports the relevance of communication management, institutional support, infrastructure, and motivation in achieving learning outcomes. However, many studies treat these factors separately, focus on non-frontier settings, or provide descriptive accounts without integrating them into a coherent explanatory model for border regions. The key gap addressed here is the lack of an empirically tested, management-science-oriented model that explains learning effectiveness in frontier schooling as a function of coordination capability (communication management), cross-actor governance capacity (TNI educational role), enabling assets (infrastructure), and motivational conditions. To enhance interpretability and policy relevance, this study applies a parsimonious framework: three direct pathways to learning effectiveness (communication management, TNI educational role, infrastructure) and a single moderator (student motivation) that conditions these relationships. This structure supports more precise managerial and policy recommendations for border-region educational management while remaining theoretically grounded as in Figure 1.

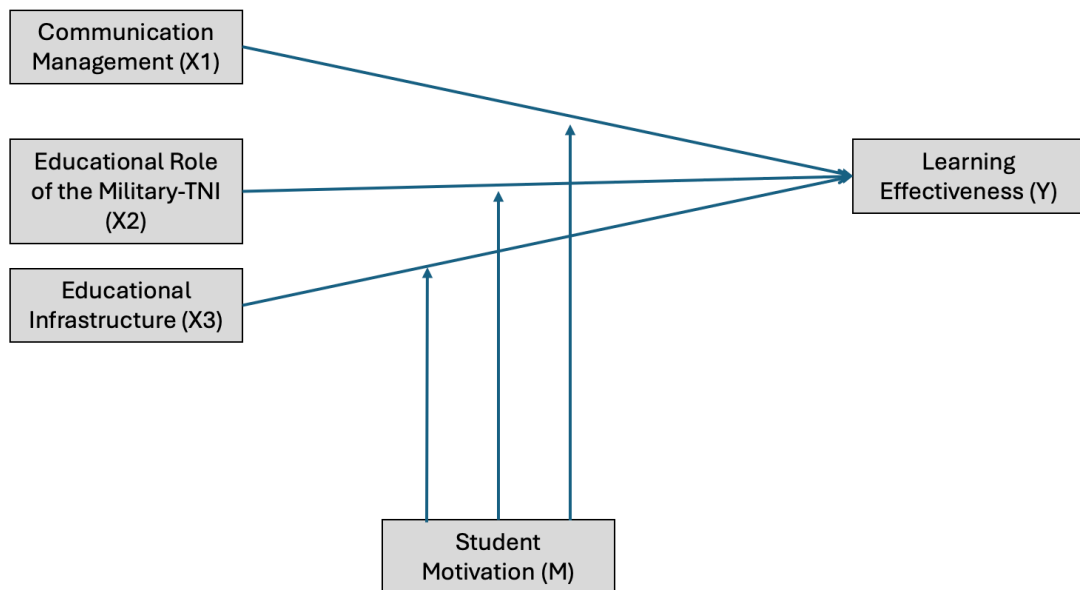


Figure 1. Conceptual Framework
Source: Author's Conceptualization (2025)

RESEARCH METHOD

This study employs a quantitative explanatory approach with a survey method, aiming to examine the influence of communication management, the educational role of the Indonesian National Armed Forces (TNI), and educational infrastructure on learning effectiveness, with student learning motivation as a moderating variable. The research model is analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS), as it is suitable for testing complex models, accommodating non-normal data distributions, and working effectively with moderate sample sizes (J. F. Hair et al., 2013).

This study was conducted in the Tanimbar Islands, Maluku, because the area represents a frontier (3T) context where educational service delivery is constrained by geographic dispersion and limited resources. The research employed a quantitative, cross-sectional survey design, and the proposed relationships were analyzed using Partial Least Squares–Structural Equation Modeling (PLS-SEM) in SmartPLS (Legate et al., 2024).

The study population comprised all junior and senior high school students in the Tanimbar Islands actively enrolled during the academic year. The sampling followed a two-stage approach. In Stage 1, stratified cluster sampling was applied to select schools as clusters across relevant strata within the study area. In Stage 2, respondents were selected within the chosen schools using random selection where feasible. When random selection was not feasible due to access or attendance constraints, purposive sampling was applied using the following inclusion criteria:

(1) students had participated in the learning process for at least one semester, (2) were actively engaged in school activities, and (3) voluntarily agreed to participate as respondents. The sample size was determined using the 10-times rule in SEM-PLS, requiring at least 10 times the number of arrows pointing to the most complex construct (F. J. Hair et al., 2016). Since learning effectiveness received four paths (X1, X2, X3, and moderation interactions), the minimum sample required was 40 respondents. However, to ensure stable estimation in moderation testing and bootstrapping analysis, at least 200 respondents were targeted.

The research instrument was a questionnaire using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Each construct was measured by several indicators adapted from established theories and prior studies. The communication management construct included indicators such as clarity of objectives, consistency of information, accuracy of delivery, availability of feedback channels, and teacher responsiveness (Effendy, 2018). The educational role of TNI comprised indicators of involvement in teaching activities, academic contribution, role modeling in discipline, and character building (Prakoso, 2019). Educational infrastructure covered classroom adequacy, learning facilities, laboratories, libraries, and access to learning media (Supriyadi, 2020). Learning motivation was adapted from Self-Determination Theory (Deci & Ryan, 2000), including indicators of persistence, learning autonomy, goal orientation, and perseverance in facing difficulties. Learning effectiveness included indicators of goal achievement, student engagement, material comprehension, and satisfaction with the learning process (Bloom, 1982). The instrument was validated through expert judgment in education and communication, and pilot tested with 30 respondents to ensure item clarity.

Table 1. Variable and Indicators

Variable	Indicator	Source
Communication Management (X1)	X1.1. Clarity of learning objectives	Effendy (2018); Suryadi (2021)
	X1.2. Consistency in information delivery	
	X1.3. Timeliness of message delivery	
	X1.4. Availability of feedback channels	
	X1.5. Teacher responsiveness to students' questions	
Educational Role of the Military (TNI) (X2)	X2.1. TNI involvement in learning activities	Prakoso (2019); Ministry of Defense of the Republic of Indonesia [Kemhan RI] (2015)
	X2.2. Usefulness of academic guidance	
	X2.3. Role modeling in discipline	
	X2.4. Character and nationalism development	
	X2.5. Collaboration between TNI and schools	
Educational Infrastructure (X3)	X3.1. Adequacy of classrooms	Tilaar (2017); Supriyadi (2020)
	X3.2. Availability of teaching materials/learning media	
	X3.3. Access to library/laboratory	
	X3.4. Availability of technological facilities (ICT)	
	X3.5. Maintenance of facilities	
Learning Motivation (M)	M1. Perseverance in completing assignments	Deci & Ryan (2000); Schunk, Pintrich, & Meece (2014); Pintrich (2003)
	M2. Goal-oriented learning	
	M3. Learning autonomy	
	M4. Persistence in facing difficulties	
	M5. Active participation in learning	
Learning Effectiveness (Y)	Y1. Achievement of learning objectives	Bloom (1982); Nurlina (2020)
	Y2. Student engagement/participation	
	Y3. Students' understanding of learning material	
	Y4. Quality of learning interactions	
	Y5. Student satisfaction with the learning process	

Source: Author's Compilation (2025)

Data collection was carried out through both offline distribution in schools and online surveys via a web link. Each respondent was provided with information about the research objectives, confidentiality rights, and informed consent. The data were anonymous and used solely for academic purposes. To address potential common method bias (CMB), procedural remedies such as randomized item order, construct block separation, and confidentiality assurance were implemented.

Data analysis was conducted using SEM-PLS procedures with SmartPLS 4 software. First, preliminary checks were performed, including data cleaning, outlier detection, and descriptive analysis. Second, the measurement model (outer model) was assessed for validity and reliability of indicators. The criteria applied were outer loadings ≥ 0.70 , Composite Reliability (CR) between 0.70–0.95, Average Variance Extracted (AVE) ≥ 0.50 , and Cronbach's Alpha ≥ 0.70 (J. F. Hair et al., 2017). Discriminant validity was tested using the HTMT criterion (< 0.85) and the Fornell–Larcker method. Third, the structural model (inner model) was evaluated through coefficient of determination (R^2) for dependent variables, effect sizes (f^2), and predictive relevance (Q^2). Path significance was tested using bootstrapping with 5,000 resamples, reported in terms of path coefficients, t-values, p-values, and 95% confidence intervals (Sarstedt et al., 2021).

For moderation testing, the product indicator approach was applied by constructing interaction terms ($X1 \times M$, $X2 \times M$, $X3 \times M$) through multiplication of reflective indicators from each construct. The interaction path coefficients were tested to determine whether student motivation strengthened or weakened the effect of independent variables on learning effectiveness. Significant interactions were further examined using simple slope analysis to illustrate differences in effects among students with high versus low motivation levels.

Through this research design, the study is expected to provide valid and reliable empirical findings on the factors influencing learning effectiveness in border areas. Beyond its theoretical contribution to border education literature, the study also aims to generate practical recommendations for local governments, schools, and the TNI in efforts to improve the quality of education in the Tanimbar Islands, Maluku.

RESULTS

This section presents the main findings from the data analysis using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach. The analysis was conducted in two stages: the evaluation of the outer model to assess the validity and reliability of the indicators, and the evaluation of the inner model to examine the relationships among latent variables, the coefficient of determination (R^2), predictive relevance (Q^2), effect size (f^2), and path significance (path coefficients). The results of these tests provide empirical evidence regarding the influence of communication management, the educational role of the military (TNI), and educational infrastructure on learning effectiveness, with students' learning motivation as a moderating variable in the border region of the Tanimbar Islands (see Table 2 for demographic clarification).

Table 2. Respondents Demographics

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	110	55.0
	Female	90	45.0
Age	13–14 years	60	30.0
	15–16 years	80	40.0
	17–18 years	60	30.0
Grade Level	Junior High School (SMP)	100	50.0
	Senior High School (SMA/SMK)	100	50.0
Residence Location	Rural Area	120	60.0
	Urban Area	80	40.0
Parental Occupation	Fisherman	70	35.0
	Farmer	60	30.0
	Government/Private Employee	40	20.0
	Others	30	15.0

Based on Table 2, the study involved 200 students with a relatively balanced gender composition (55% male; 45% female). Most respondents were aged 15–16 years (40%), while those aged 13–14 and 17–18 years each accounted for 30%. Educational level was evenly split between junior high and senior high/vocational school (50% each). Most students lived in rural areas (60%). Parents' occupations were mainly fishermen (35%) and farmers (30%), followed by government/private employees (20%) and others (15%), indicating predominantly traditional household livelihoods that may shape educational motivation and support in the border region.

Evaluation of the Outer Model

Table 3 shows that all construct indicators have loadings above 0.70, with one marginal item (X1.4 = 0.708). X1.4 was retained because its loading remains acceptable and it is important for preserving the conceptual coverage of the communication management construct, though its stability should be rechecked in future studies. In terms of reliability, the Cronbach's Alpha values for all constructs ranged from 0.82 to 0.88, while the Composite Reliability (CR) values ranged between 0.88 and 0.93. Both results indicate that all constructs have high internal reliability (>0.70) (J. F. Hair et al., 2017). Furthermore, the Average Variance Extracted (AVE) values were in the range of 0.60–0.70, thereby meeting the criteria for convergent validity (AVE > 0.50).

Table 3. Outer Model Evaluation (Construct Reliability & Validity)

Laten Variable	Indicator	Loading	Alpha	CR	AVE
Communication Management (X1)	X1.1	0.850	0.82	0.88	0.60
	X1.2	0.883			
	X1.3	0.823			
	X1.4	0.708			
	X1.5	0.819			
Educational Role of the Military-TNI (X2)	X2.1	0.849	0.84	0.89	0.62
	X2.2	0.808			
	X2.3	0.749			
	X2.4	0.833			
	X2.5	0.871			
Educational Infrastructure (X3)	X3.1	0.841	0.83	0.90	0.64
	X3.2	0.837			
	X3.3	0.789			
	X3.4	0.876			
	X3.5	0.813			
Student Motivation (M)	M1	0.894	0.87	0.92	0.68
	M2	0.871			
	M3	0.853			
	M4	0.887			
	M5	0.840			
Learning Effectiveness (Y)	Y1	0.910	0.88	0.93	0.70
	Y2	0.893			
	Y3	0.888			
	Y4	0.917			
	Y5	0.833			

Inner Model Evaluation

Accordingly, the measurement model can be considered valid and reliable and is therefore suitable for further testing of the structural model (inner model) in the subsequent stage. Figure 2 shows that Communication Management (X1) has the strongest effect on Learning Effectiveness (Y) ($\beta = 0.429$), indicating that clear objectives, consistent information, and teacher responsiveness are key in border-area learning. The Educational Role of the TNI (X2) also significantly improves learning effectiveness ($\beta = 0.391$) through discipline, character-building, and nationalism support. Educational Infrastructure (X3) positively affects learning effectiveness

($\beta = 0.357$) and increases Student Motivation (M) ($\beta = 0.269$), while motivation also improves learning effectiveness ($\beta = 0.318$), suggesting a mediating role. Overall, learning effectiveness is shaped by the combined contributions of communication management, TNI educational support, infrastructure, and reinforced by student motivation.

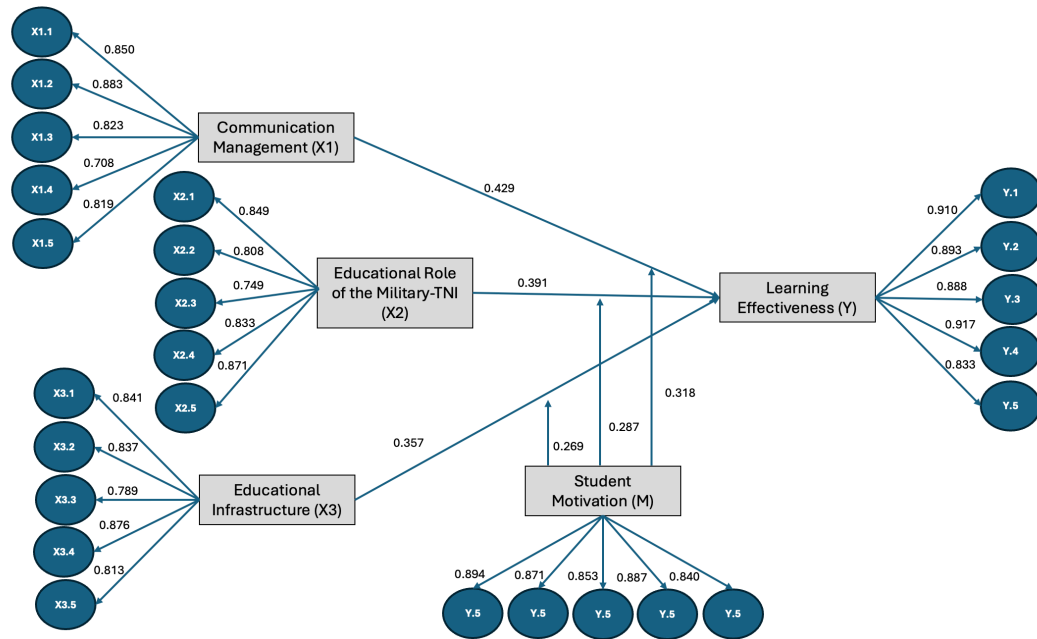


Figure 2. Results of SEM-PLS Structural Model Analysis

Table 4 presents the results of the structural model evaluation, including path coefficients, effect sizes (f^2), t -values, and statistical significance levels, which further validate the hypothesized relationships among the constructs.

Tabel 4. Path Coefficient, f^2 , t -value, and statistical significance levels

Relationship Between Variables	Path	f^2	t -value	p -value
Communication Management (X1) → Learning Effectiveness (Y)	0.429	0.180	4.210	0.000
Educational Role of the Military-TNI (X2) → Learning Effectiveness (Y)	0.391	0.160	3.980	0.000
Educational Infrastructure (X3) → Learning Effectiveness (Y)	0.357	0.140	3.550	0.000
Student Motivation (M) → Learning Effectiveness (Y)	0.318	0.120	3.120	0.002
Communication Management (X1) → Student Motivation (M)	0.269	0.090	2.870	0.004
Educational Role of the Military-TNI (X2) → Student Motivation (M)	0.287	0.100	3.050	0.002
Educational Infrastructure (X3) → Student Motivation (M)	0.291	0.110	2.980	0.003
Communication Management (X1) × M → Learning Effectiveness (Y)	0.121		2.35	0.019
Educational Role of TNI (X2) × M → Learning Effectiveness (Y)	0.134		2.68	0.008
Educational Infrastructure (X3) × M → Learning Effectiveness (Y)	0.118		2.21	0.027

Table 4 shows that Communication Management (X1), the Educational Role of the TNI (X2), and Educational Infrastructure (X3) significantly improve Learning Effectiveness (Y), with path coefficients of 0.429, 0.391, and 0.357. Student Motivation (M) also positively affects learning effectiveness ($\beta = 0.318$). In addition, X1, X2, and X3 significantly increase student motivation, with coefficients of 0.269, 0.287, and 0.291, indicating that communication quality, institutional support, and infrastructure contribute to stronger motivation that supports learning outcomes. Table 5. presents moderate explanatory power for Student Motivation ($R^2 = 0.42$), meaning Communication Management, the TNI's educational role, and Infrastructure explain 42% of its variance. Learning Effectiveness has strong explanatory power ($R^2 = 0.58$), with X1, X2, X3, and Motivation explaining 58% of its variance. Predictive relevance is supported by $Q^2 = 0.25$ (Motivation) and $Q^2 = 0.39$ (Learning Effectiveness), indicating the model has good predictive capability in border-area learning contexts.

Table 5. Coefficient of Determination (R^2) and Predictive Relevance (Q^2)

Endogenous Construct	R^2	Q^2	Note
Student Motivation (M)	0.420	0.250	Moderate R^2 ; variables X1, X2, and X3 explain 42% of the variance in student motivation.
Learning Effectiveness (Y)	0.580	0.390	Strong R^2 ; variables X1, X2, X3, and M explain 58% of the variance in learning effectiveness.

DISCUSSION

Learning effectiveness in frontier and border-region schools emerges in this study not as a narrow pedagogical outcome, but as a management problem shaped by coordination, institutional capacity, and enabling resources operating under severe constraints. In geographically isolated settings such as the Tanimbar Islands, educational performance reflects the system's ability to organize action across actors, stabilize routines, and convert scarce inputs into consistent learning experiences. This framing aligns border education with public service management scholarship that treats performance as an implementation outcome conditioned by coordination quality, resource deployment, and governance arrangements in constrained systems (Boyne, 2002; Andrews et al., 2017).

At the center of this system lies communication management, which functions as a coordination capability rather than a simple administrative task. In frontier contexts, where operational disruptions, limited supervision, and uneven access are common, structured communication reduces ambiguity, aligns expectations, and stabilizes learning routines. Clear goal articulation, message consistency, and feedback loops reduce process uncertainty and help students navigate instructional demands with greater confidence. This finding reinforces educational management arguments that emphasize communication clarity and feedback as core mechanisms for sustaining engagement and persistence, particularly under constraint (Fletcher, 1990; Thain et al., 2008; Gaikwad & Choudhary, 2024). Consistent with military and defense education research, communication here operates not merely as information transfer but as an organizing device that aligns routines, standards, and performance expectations (Amirlu, 2025).

The educational involvement of the Indonesian National Armed Forces (TNI) illustrates how cross-actor governance can augment implementation capacity in contexts where civilian delivery systems face structural limitations. Rather than substituting for formal educational institutions, the TNI contributes through functional governance mechanisms such as discipline reinforcement, mentoring continuity, and the stabilization of institutional routines. This supports collaborative governance perspectives, which argue that additional institutional actors can enhance reliability and execution capacity in settings marked by limited resources and high uncertainty (Ansell & Gash, 2007). Prior studies in military and defense education similarly show that structured routines, mentoring, and disciplined support improve learning reliability and character formation (Barreiros dos Santos et al., 2019; Boye & Agyei, 2025), while stakeholder engagement strengthens curriculum implementation and outcomes (Haile & Mekonnen, 2024).

Importantly, the contribution observed here reflects functional governance value rather than symbolic institutional presence.

Infrastructure functions as the material foundation that enables coordination and governance mechanisms to translate into effective learning. In frontier regions, classrooms, learning materials, and basic facilities are not passive background conditions but active determinants of whether learning routines can be executed consistently. Adequate infrastructure reduces friction in instructional delivery, increases participation, and improves comprehension by allowing teacher and student effort to be converted more efficiently into learning progress. This interpretation aligns with military and distance education research demonstrating that facilities and instructional resources reduce operational bottlenecks and improve learning participation and effectiveness (Newton & Ellis, 2005; Tung et al., 2009; Ščavničar, 2023). In contexts with uneven baseline provision, infrastructure investments yield particularly high marginal returns by stabilizing execution capacity (Hentea et al., 2003; Ziberi & Sylva, 2025).

Student motivation threads through these structural elements as both an independent driver and a conditioning force. Motivation determines whether external inputs such as communication clarity, institutional support, and infrastructure investment translate into actual learning gains. Where students exhibit persistence, goal orientation, and engagement, organizational and governance interventions become more productive; where motivational readiness is weak, even well-designed systems produce muted outcomes. This pattern is consistent with military education literature positioning motivation, discipline, and goal orientation as central to learning performance (Iancu et al., 2017; Lepinoy et al., 2022; Gao, 2025). It reinforces arguments that structural and governance interventions should be paired with motivational reinforcement mechanisms such as feedback, recognition, and competence-building routines rather than delivered as stand-alone solutions (Amirlu, 2025).

The findings reframe learning effectiveness in border regions as the product of coordinated management capabilities, cross-actor implementation capacity, enabling assets, and motivational readiness. The added contribution lies in demonstrating that under high constraint, the marginal returns of coordination routines, governance support, and infrastructure investment are amplified, while motivation functions as a critical boundary condition determining whether these inputs translate into performance gains. By operationalizing learning effectiveness through coordination capability, cross-actor governance, enabling assets, and motivational readiness, the study situates border education firmly within management science debates on performance in constrained public service systems rather than treating learning outcomes as purely pedagogical phenomena.

CONCLUSION AND FURTHER STUDY

This study concludes that learning effectiveness in frontier and border-region schools is fundamentally a management and governance outcome rather than a purely instructional one. In the Tanimbar Islands, effective learning is shaped by the system's capacity to coordinate action through communication management, to mobilize cross-actor implementation support through the educational role of the TNI, and to provide enabling infrastructure that allows learning routines to function reliably. These structural and organizational factors do not operate in isolation; their effectiveness is contingent on students' motivational readiness, which determines whether external inputs translate into sustained engagement and learning progress. Conceptually, the findings position border education performance within management science by demonstrating how coordination capability, implementation capacity, and enabling assets jointly condition outcomes in high-constraint public service systems.

From a managerial and policy perspective, the implications are presentable. Improving learning outcomes in border regions requires more than incremental pedagogical reforms. Education authorities should prioritize strengthening communication routines that stabilize expectations and execution, formalize cross-actor collaboration mechanisms that enhance continuity and monitoring, and target infrastructure investments toward removing operational bottlenecks rather than pursuing symbolic upgrades. Equally important, these interventions should be designed alongside deliberate efforts to reinforce student motivation through feedback, recognition, and structured engagement, as motivation amplifies the returns on organizational and institutional inputs.

This study is subject to several limitations. First, its cross-sectional design constrains causal inference and limits insight into how coordination mechanisms and institutional support evolve over time. Second, the focus on a single border region may restrict the generalizability of the findings to other frontier contexts with different governance arrangements or resource endowments. Third, reliance on self-reported data may introduce perceptual bias, particularly in assessing motivation and learning effectiveness, despite efforts to ensure construct validity. Future research should extend this work in several directions. Comparative studies across multiple border and frontier regions would help assess the external validity of the coordination–capacity framework and identify contextual contingencies. Longitudinal designs could capture how changes in communication routines, cross-actor support, and infrastructure investment shape learning effectiveness over time. Mixed-method approaches would further illuminate the mechanisms through which military involvement and communication management influence student engagement and daily learning routines. Finally, alternative model structures, including mediation and moderated-mediation designs, could refine understanding of the causal pathways linking governance arrangements, motivation, and learning outcomes.

ACKNOWLEDGMENTS

The authors thank the education authorities, school principals, teachers, and students in the Tanimbar Islands for their cooperation and support during data collection. The authors also acknowledge the assistance of local stakeholders who facilitated field access and coordination during the research process.

ETHICAL DISCLOSURE

This study was conducted in accordance with established ethical research standards. Prior to data collection, all respondents were informed about the objectives of the study, the voluntary nature of their participation, and their right to withdraw at any time without any negative consequences. Informed consent was obtained from all participants before completing the questionnaire. The confidentiality and anonymity of respondents were strictly maintained, and all data were used solely for academic purposes. No personal identifiers were collected, and the results are reported in aggregate form. The study did not involve any physical, psychological, or social harm to participants.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this research. The study was conducted independently, without any financial, institutional, or personal relationships that could be perceived as influencing the findings and interpretations presented in this paper.

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