KOMUNITAS
ISSN 2086 - 7808 (Print) ISSN 2746 - 6116 (Online)
JURNAL ILMU SOSIOLOGI

**Volume 9 Issue 1** | MAY 2026
e-ISSN: 2746-6116 | p-ISSN: 2086-7808
https://ojs3.unpatti.ac.id/index.php/komunitas

# Beyond Infrastructure: Personnel Capability, Power Reliability, and the Social Production of Operational Effectiveness in Border Security

https://doi.org/10.30598/komunitasvol9issue1page38-53

**I Wayan Agus Suhardiyanto[1*], Ferdinand Hasudungan[1], Oktaheroe Ramsi[1]**
[1]Universitas Pertahanan, Jl. Anyar, Sukahati, Kec. Citeureup, Kabupaten Bogor, Jawa Barat 16810, Indonesia

***Abstract***

*This study examines border security operational effectiveness beyond technological determinism by emphasizing its social production through personnel capability and power system reliability. Challenging policy and technical discourses that privilege infrastructure as the primary driver of performance, the study conceptualizes effectiveness as a socio-technical outcome shaped by the interaction of technology, human skills, and organizational conditions in geographically isolated regions. Using a quantitative explanatory design, data were collected from 185 personnel of outer island security task forces under Kodam XV/Pattimura. Hybrid satellite communication utilization, personnel capability, power system reliability, and communication–electronic effectiveness were measured through structured questionnaires and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings show that personnel capability exerts a strong and significant positive effect on operational effectiveness, whereas communication technology and power reliability display no significant direct effects when considered independently. However, their simultaneous interaction generates a substantial synergistic effect, explaining over 80% of the variance in effectiveness. These results indicate that infrastructure and energy systems function primarily as enabling conditions, while performance emerges from the capacity of personnel to translate technological potential into coordinated organizational action. The study contributes to socio-technical systems theory, extends organizational sociology to security institutions, and provides rare empirical evidence from peripheral state contexts in the Global South.*

**Article Info:**

***Keywords***: *Border Security, Human Capital, Organizational Capacity, Power System Reliability, Socio-Technical Systems*

***Correspondence E-Mail:***
ajuscigra@gmail.com

***Received manuscript***: *08/12/2025*
***Final revision***: *28/01/2026*
***Approved***: *29/01/2026*
***Online Access***: *31/01/2026*
***Published***: *30/05/2026*



***Publisher:*** *Jurusan Bahasa dan Seni FKIP Universitas Pattimura, Jl. Ir. M. Putuhena, Kampus Universitas Pattimura, Poka, Ambon 97233*
***E-mail:***
*komunitas.jurnalsosiologi@gmail.com*



**How to cite:** Suhardiyanto, I. W. A., Hasudungan, F., & Ramsi, O. (2026). Beyond Infrastructure: Personnel Capability, Power Reliability, and the Social Production of Operational Effectiveness in Border Security. *Komunitas: Jurnal Ilmu Sosiologi, 9*(1), 38-53. https://doi.org/10.30598/komunitasvol9issue1page38-53

## INTRODUCTION

Border security operations in geographically peripheral regions increasingly rely on advanced communication infrastructures to overcome spatial isolation, limited accessibility, and logistical constraints. In many contemporary security doctrines, particularly within developing and archipelagic states, the deployment of hybrid satellite-based communication systems is framed as a strategic solution for enhancing coordination, surveillance, and rapid response capabilities (Fathoni et al., 2025; Lehmann & Wiertz, 2025). Indonesia, as a maritime nation with extensive outer islands bordering multiple countries, exemplifies this approach through substantial investments in satellite communication technologies to support military and security operations in remote border zones. However, despite the growing sophistication and availability of communication hardware, empirical realities in these regions reveal persistent operational challenges (Komalasari & Mustafa, 2024). Communication disruptions, delayed command transmission, and fragmented coordination continue to occur, even in contexts where technological infrastructure is formally present and operational (Mayndarto, 2025).

These conditions point to a deeper problem that cannot be adequately explained by technological limitations alone. Field reports and institutional evaluations from remote border operations repeatedly indicate that operational failures often coincide with uneven personnel competence, limited technical training, high personnel turnover, and unstable power supply systems (Harianja, 2025; Risal et al., 2022). In many outer island security posts, electricity depends on diesel generators with inconsistent fuel availability, while personnel assigned to operate advanced communication equipment frequently lack sufficient training or experience to fully utilize these systems. As a result, technological capacity remains underused or misapplied, producing a gap between infrastructure potential and actual operational performance. This discrepancy raises an important sociological question regarding how operational effectiveness is produced, maintained, or undermined within organizational settings characterized by structural vulnerability and human resource constraints (Caruso et al., 2024; Polnaya et al., 2023).

Existing policy narratives tend to interpret these challenges through a technocratic lens, emphasizing the need for additional hardware, expanded coverage, or more advanced communication platforms. Such perspectives implicitly assume that technology operates as an autonomous driver of effectiveness, largely independent of social conditions. Yet sociological and organizational research has long demonstrated that technology does not function in a vacuum; rather, it is embedded within social systems shaped by human agency, institutional norms, and material constraints (Hieng & Prabawati, 2024; Shao & Razzaq, 2022; Siregar et al., 2024). From this standpoint, operational effectiveness in border security should be understood not merely as a technical output, but as a socially mediated process in which human capability, organizational routines, and infrastructural reliability interact dynamically.

A substantial body of literature in security studies and military research has focused on the technical dimensions of communication systems, emphasizing metrics such as bandwidth capacity, signal reliability, system interoperability, and hardware resilience (Bangun et al., 2024; Setyadi, Pawirosumarto, & Damaris, 2025). These studies provide valuable insights into the engineering performance of communication technologies, yet they often abstract these systems from the organizational environments in which they are deployed (Ravlinko et al., 2023; Septiari & Prabawati, 2025). As a consequence, the social conditions that enable or constrain technological use, such as personnel training, experiential knowledge, and institutional learning, remain underexplored.

Parallel to this, research in border security and strategic studies has predominantly examined borders as geopolitical spaces shaped by sovereignty claims, transnational threats, and migration flows (Jahanger, 2022; Mustika & Indrady, 2024). While this literature has significantly advanced understanding of borders as political and symbolic constructs, it tends to operate at a macro level, paying limited attention to the micro-organizational foundations of daily security operations. The routine practices of personnel stationed in remote border posts, their interaction with technology, and the infrastructural fragilities they navigate are often treated as peripheral details rather than central analytical concerns.

Within organizational sociology and public administration, a growing body of work highlights the role of human capital, institutional capacity, and learning processes in shaping organizational performance, particularly in resource-constrained environments (Emmanuel et al., 2023; Rahim et al., 2024). Studies in this tradition emphasize that formal structures and material resources alone are insufficient to produce effective outcomes without corresponding investments in skills, norms, and coordination mechanisms. However, these insights have rarely been applied systematically to military or border security institutions, which are often assumed to function through hierarchical command and standardized procedures, minimizing the relevance of sociological variability.

Socio-technical systems theory provides a conceptual bridge between these bodies of literature by arguing that technological systems are inseparable from the social arrangements within which they operate (Bharoto et al., 2025; Setyadi, Pawirosumarto, Damaris, et al., 2025). From this perspective, communication infrastructures are not merely tools but components of broader systems that include human actors, organizational routines, and material supports such as energy supply. Recent studies applying socio-technical approaches to infrastructure governance and digital systems demonstrate that failures frequently emerge not from technological breakdowns per se, but from misalignments between technology, skills, and institutional contexts (Coupet, 2025; Latuheru et al., 2024). Yet empirical applications of this framework to border security operations, particularly in peripheral regions of the Global South, remain scarce.

Energy reliability represents another critical yet underexamined dimension of operational effectiveness. Research on infrastructure and development consistently shows that unstable power supply undermines institutional performance, especially in remote and rural settings (Karakurt, 2021; Pradita, 2025; Salsinha & Lukman, 2024). In security operations, where communication systems are energy-intensive and time-sensitive, power disruptions can have cascading effects on coordination and situational awareness. Nonetheless, energy systems are often treated as background conditions rather than integral components of security performance, resulting in analytical blind spots regarding their interaction with human and technological factors.

Against this backdrop, a pattern emerges in which technological infrastructure is frequently foregrounded, while human capability and infrastructural reliability are relegated to secondary status. This imbalance obscures the social processes through which operational effectiveness is actually produced on the ground. In peripheral border regions, where institutional support is limited and environmental challenges are pronounced, these social dimensions become even more consequential. Understanding why advanced communication systems fail to deliver consistent operational outcomes thus requires moving beyond deterministic assumptions and examining the organizational conditions under which technology is enacted.

This study is situated precisely within this analytical space. Rather than treating communication technology as an independent variable with automatic effects, it approaches border security operations as socio-technical arrangements shaped by the interaction of personnel capability, power system reliability, and technological utilization. By empirically examining these relationships within the context of Indonesia's outer island security task forces, the study brings together insights from security studies, organizational sociology, and socio-technical systems theory in a unified analytical framework. The emphasis on personnel capability as an active mediating force reflects an implicit shift in perspective, one that re-centers human agency and organizational capacity in discussions of operational effectiveness.

The research is guided by the premise that operational performance is not simply installed through infrastructure, but cultivated through skills, experience, and the ability to adapt technology to challenging environments. In doing so, it seeks to demonstrate that communication systems derive their effectiveness from the social conditions that sustain their use. The quantitative explanatory design employed in this study allows for systematic assessment of these relationships, while the sociological interpretation of the findings foregrounds issues of capacity, inequality, and peripheral governance.

Accordingly, the primary objective of this research is to analyze border security operational effectiveness as a socially mediated outcome, shaped by personnel capability and power reliability alongside communication technology. Specifically, the study aims to assess the relative influence of human capability compared to technological infrastructure, examine how energy systems condition technological use, and explore the synergistic interactions that produce effective or ineffective operational outcomes. By articulating these dynamics, the study aspires to contribute not only to empirical knowledge of border security operations, but also to broader debates in social and political science concerning state capacity, technological governance, and the social foundations of security in peripheral regions.

## RESEARCH METHOD

This study adopts a quantitative approach with an explanatory research design to elucidate the causal relationships among variables influencing the effectiveness of communication and electronics in border security operations. The quantitative approach is employed because the primary objective of this research is not merely to describe phenomena, but to empirically test the strength of effects and interactions among communication technology, personnel capability, and power system reliability on operational effectiveness. Within the context of complex and multi-layered security organizations, this approach enables the systematic measurement of latent constructs, such as personnel capability and operational effectiveness, and allows for an objective assessment of the relative contribution of each factor (Freitas et al., 2025; García-Collado et al., 2023).

The research site is focused on the operational area of Kodam XV/Pattimura, which encompasses Indonesia's outermost islands in the Maluku region. The selection of this location is grounded in both empirical and sociological considerations. The region represents a peripheral state space that is geographically isolated, characterized by limited basic infrastructure, and heavily dependent on satellite-based communication systems, particularly VSAT Manpack, to support security operations. These conditions position Kodam XV/Pattimura as a relevant social laboratory for examining how operational effectiveness is produced under conditions of structural constraints, as highlighted in studies on state capacity in peripheral regions (Chang et al., 2024; Pradnyani & Prabawati, 2025).

The study population consists of 338 personnel from task forces assigned to secure outermost islands who have implemented the VSAT Manpack communication system, both within Kodam XV/Pattimura and in several other task forces utilizing similar systems. This population was selected because its members possess direct operational experience in using communication systems, managing energy limitations, and performing security functions in real field conditions. The number of respondents was determined using Slovin's formula with a 95% confidence level and a 5% margin of error, resulting in a sample size of 183 respondents. This approach was chosen to ensure data representativeness while maintaining a balance between statistical rigor and the practical constraints of field access in military operational areas (Majdi et al., 2025).

Data were collected using a closed-ended questionnaire consisting of 39 statements measured on a five-point Likert scale, ranging from strongly disagree to strongly agree. The questionnaire method was selected because it allows for standardized measurement of personnel perceptions and operational experiences, while simultaneously facilitating the analysis of relationships among latent variables. The instrument was designed to capture four main variables: integrated VSAT Manpack hybrid communication, personnel capability, power system reliability, and the effectiveness of communication and electronics. The indicators were developed based on established literature on military communication systems, human capital, and the reliability of supporting infrastructure (Kurniawan et al., 2024; Sinaga et al., 2024).

Data validation was conducted through validity and reliability testing using the Structural Equation Modeling–Partial Least Squares (SEM-PLS) approach with SmartPLS software. This method was selected due to its suitability for analyzing complex models with latent constructs, moderate sample sizes, and data distributions that do not necessarily meet normality assumptions (Wibisono et al., 2024). Convergent and discriminant validity tests were employed to ensure that each indicator consistently represented the intended construct, while reliability was assessed using composite reliability and Cronbach's alpha. Subsequently, structural analysis was performed to evaluate both direct and simultaneous relationships among variables, enabling a more comprehensive understanding of how operational effectiveness is shaped through the interaction of technology, human resources, and energy systems within security organizations operating in peripheral regions.

## RESULTS AND DISCUSSION

### Respondent Characteristics

This study involved 185 respondents who constituted the research sample. The number of respondents exceeded the minimum sample size calculated using Slovin's formula, indicating a high level of participation. This strong participation reflects personnel enthusiasm and concern regarding the development of communication systems within their operational areas. The demographic characteristics of the respondents, based on military rank and unit of assignment, are presented in Table 1.

As shown in Table 1, of the 185 respondents, the majority held the rank of Private First Class (Pratu), totaling 69 personnel (37.3%), followed by Corporal Second Class (Kopda) with 25 personnel (13.5%) and Private Senior (Praka) with 22 personnel (11.9%). The dominance of enlisted personnel and non-commissioned officers is consistent with the organizational structure of communication and electronics units, where operational-level personnel are the primary users of the VSAT Manpack communication system. The smaller proportion of officers, 14 personnel in total, comprising one Lieutenant Colonel, one Major, four Captains, three First Lieutenants, and six Second Lieutenants, reflects their roles primarily as commanders and operational supervisors.

**Table 1** Distribution of Respondents by Military Rank

| Rank | Frequency | Percentage (%) |
|---|---|---|
| Lieutenant Colonel | 1 | 0.5 |
| Major | 1 | 0.5 |
| Captain | 4 | 2.2 |
| First Lieutenant | 3 | 1.6 |
| Second Lieutenant | 6 | 3.2 |
| Sergeant Major | 6 | 3.2 |
| Sergeant | 13 | 7.0 |
| Staff Sergeant | 14 | 7.6 |
| Corporal Second Class | 25 | 13.5 |
| Private Senior | 22 | 11.9 |
| Private First Class | 69 | 37.3 |
| Private | 7 | 3.8 |
| Unidentified | 13 | 7.0 |
| Total | 185 | 100.0 |

Source: Research data analysis, 2025

### Outer Model Evaluation

The outer model evaluation was conducted to assess the validity and reliability of the research instrument. This evaluation included tests of convergent validity, composite reliability, and discriminant validity. The results of the outer model assessment are presented in Table 2.

As shown in Table 2, all indicators exhibit strong outer loading values, ranging from 0.819 to 0.929. The Average Variance Extracted (AVE) values for all constructs exceed the recommended threshold of 0.50 and, in most cases, are above 0.70, indicating excellent convergent validity. These high AVE values suggest that the indicators effectively explain the variance of their respective constructs. Furthermore, Cronbach's alpha and composite reliability values ($\rho a$ and $\rho c$) for all constructs exceed 0.90, demonstrating very high internal consistency. This indicates that respondents provided consistent responses across indicators measuring the same construct and confirms that the questionnaire instrument is highly reliable for measuring the study variables.

**Table 2** Outer Model Evaluation Results

| Research Variable | Item | Outer Loadings | Average Variance Extracted (AVE) | Cronbach's Alpha | Composite Reliability (rho_a) | Composite Reliability (rho_c) |
|---|---|---|---|---|---|---|
| Integrated VSAT Manpack Hybrid Communication | KV 1 | 0.819 | 0.782 | 0.975 | 0.975 | 0.977 |
| | KV 2 | 0.900 | | | | |
| | KV 3 | 0.827 | | | | |
| | KV 4 | 0.915 | | | | |
| | KV 5 | 0.906 | | | | |
| | KV 6 | 0.893 | | | | |
| | KV 7 | 0.905 | | | | |
| | KV 8 | 0.888 | | | | |
| | KV 9 | 0.873 | | | | |
| | KV 10 | 0.899 | | | | |
| | KV 11 | 0.874 | | | | |
| | KV 12 | 0.908 | | | | |
| Personnel Capability | KP 1 | 0.847 | 0.777 | 0.964 | 0.965 | 0.969 |
| | KP 2 | 0.857 | | | | |
| | KP 3 | 0.919 | | | | |
| | KP 4 | 0.908 | | | | |
| | KP 5 | 0.877 | | | | |
| | KP 6 | 0.894 | | | | |
| | KP 7 | 0.903 | | | | |
| | KP 8 | 0.870 | | | | |
| | KP 9 | 0.854 | | | | |
| Power System | PS 1 | 0.915 | 0.801 | 0.969 | 0.970 | 0.973 |
| | PS 2 | 0.900 | | | | |
| | PS 3 | 0.877 | | | | |
| | PS 4 | 0.918 | | | | |
| | PS 5 | 0.925 | | | | |
| | PS 6 | 0.890 | | | | |
| | PS 7 | 0.891 | | | | |
| | PS 8 | 0.837 | | | | |
| | PS 9 | 0.901 | | | | |
| Communication and Electronics Effectiveness | KE 1 | 0.928 | 0.833 | 0.975 | 0.975 | 0.978 |
| | KE 2 | 0.922 | | | | |
| | KE 3 | 0.926 | | | | |
| | KE 4 | 0.909 | | | | |
| | KE 5 | 0.850 | | | | |
| | KE 6 | 0.929 | | | | |
| | KE 7 | 0.916 | | | | |
| | KE 8 | 0.901 | | | | |
| | KE 9 | 0.929 | | | | |

Source: Research data analysis, 2025

Discriminant validity was assessed using the Fornell–Larcker criterion, which requires that the square root of the AVE of each construct be greater than its correlations with other constructs. The results of the discriminant validity test are presented in Table 3.

As shown in Table 3, strong correlations are observed among all variables in the model. However, all correlation values are lower than the square root of the AVE for each respective construct (Integrated VSAT Manpack Hybrid Communication= $\sqrt{0.782} = 0.884$; Personnel Capability= $\sqrt{0.777} = 0.881$; Power System = $\sqrt{0.801} = 0.895$; Communication and Electronics= $\sqrt{0.883} = 0.913$). These results indicate that discriminant validity is satisfactorily established.

**Table 3** Discriminant Validity (Fornell–Larcker Criterion)

| Variable | Integrated VSAT Manpack Hybrid Communication | Personnel Capability | Power System | Communication and Electronics |
|---|---|---|---|---|
| Integrated VSAT Manpack Hybrid Communication | 1.000 | 0.869 | 0.811 | 0.787 |
| Personnel Capability | 0.869 | 1.000 | 0.872 | 0.891 |
| Power System | 0.811 | 0.872 | 1.000 | 0.838 |
| Communication and Electronics | 0.787 | 0.891 | 0.838 | 1.000 |

Source: Research data analysis, 2025

The next evaluation involved the R-square ($R^2$) test, which was conducted to determine the proportion of variance in the dependent variable explained by the independent variables in the model. The results of the R-square analysis are presented in Table 4.

As shown in Table 4, the R-square value for the Communication and Electronics construct is 0.810, indicating that 81% of the variance in Communication and Electronics effectiveness is explained by the three independent variables: Integrated VSAT Manpack Hybrid Communication, Personnel Capability, and Power System. The remaining 19% is explained by factors outside the proposed model. The adjusted R-square value of 0.807 suggests that, after adjusting for the number of predictors, the model retains strong explanatory power. The minimal difference between the R-square and adjusted R-square values (0.003) indicates that the model does not suffer from overfitting and demonstrates robust predictive capability.

**Table 4** R-square Values

| Variable | R-square | Adjusted R-square | Category |
|---|---|---|---|
| Communication and Electronics | 0.810 | 0.807 | Strong |

Source: Research data analysis, 2025

## Hypothesis Testing Results

Hypothesis testing in this study was conducted using the bootstrapping technique with 5,000 subsamples. A hypothesis was accepted if the t-statistic exceeded 1.96 (at a 5% significance level) and the p-value was less than 0.05. The results of hypothesis testing for each relationship among variables in the research model are presented in Table 5.

**Table 5** Hypothesis Testing Results

| Hypothesis | Structural Path | Original Sample (O) | Sample Mean (M) | Std. Deviation (STDEV) | t-Statistic | p-Value | Decision |
|---|---|---|---|---|---|---|---|
| H1 | Integrated VSAT Manpack Hybrid Communication → Communication and Electronics | −0.005 | 0.009 | 0.112 | 0.047 | 0.963 | Rejected |
| H2 | Personnel Capability → Communication and Electronics | 0.673 | 0.652 | 0.180 | 3.736 | < .001 | Accepted |
| H3 | Power System → Communication and Electronics | 0.256 | 0.263 | 0.182 | 1.404 | 0.160 | Rejected |
| H4 | Integrated VSAT Manpack Hybrid Communication, Personnel Capability, and Power System → Communication and Electronics | 0.881 | 0.883 | 0.036 | 24.181 | < .001 | Accepted |

Source: Research data analysis, 2025

Based on Table 5, two of the four proposed hypotheses are supported, while the remaining two are rejected. The interpretation of each hypothesis is provided below.

H1 posited that Integrated VSAT Manpack Hybrid Communication has a negative and non-significant effect on Communication and Electronics. The estimated path coefficient is −0.005, indicating an extremely weak negative effect, effectively approaching zero. The t-statistic (0.047) is far below the critical value of 1.96, and the p-value (0.963) exceeds 0.05, confirming the absence of statistical significance. Accordingly, H1 is rejected. This rejection does not imply that the VSAT Manpack system is unimportant or ineffective. The relatively high correlation between Integrated VSAT Manpack Hybrid Communication and Communication and Electronics (0.787) suggests a strong association. However, the non-significant direct effect indicates that the effectiveness of VSAT Manpack utilization in enhancing communication and electronics outcomes is highly contingent on other factors, particularly personnel capability in operating the system and the availability of a reliable power system. The sample mean (0.009) and standard deviation (0.112) further indicate substantial variability across subsamples, suggesting that the effect of VSAT Manpack is inconsistent and context-dependent. This finding is noteworthy, as it contrasts with several prior studies reporting significant effects of satellite communication technologies on operational effectiveness.

H2 proposed that Personnel Capability has a positive and significant effect on Communication and Electronics. The results show a path coefficient of 0.673, indicating that a one-unit increase in personnel capability leads to a 0.673-unit increase in Communication and Electronics effectiveness, holding other variables constant. The t-statistic (3.736) exceeds the critical threshold of 1.96, and the p-value (0.000) is below 0.05, confirming statistical significance. Thus, H2 is accepted. This finding confirms that personnel capability exerts a strong and positive influence on the effectiveness of communication and electronics in supporting the operational functions of the Outer Island Security Task Force within Kodam XV/Pattimura. The sample mean (0.652) indicates stability across subsamples, while the relatively low standard deviation (0.180) suggests a precise and reliable parameter estimate.

H3 posited that the Power System has a negative and non-significant effect on Communication and Electronics. Empirically, the path coefficient is positive (0.256), indicating that improvements in the power system are associated with increased effectiveness of communication and electronics. However, the t-statistic (1.404) does not reach the critical value of 1.96, and the p-value (0.160) exceeds 0.05, rendering the effect statistically non-significant. Consequently, H3 is rejected. Despite the lack of statistical significance, the magnitude of the path coefficient suggests a practically meaningful positive effect. The t-statistic approaching the critical threshold indicates borderline significance, implying that the effect may exist but is not sufficiently strong to meet the established statistical criteria. The sample mean (0.263) and standard deviation (0.182) indicate considerable variability, which can be attributed to heterogeneous field conditions in the Maluku region, particularly differences in the availability and quality of power supply systems across deployment locations.

H4 hypothesized that Integrated VSAT Manpack Hybrid Communication, Personnel Capability, and the Power System jointly exert a significant effect on Communication and Electronics in supporting the operational tasks of outer island security units in Kodam XV/Pattimura. The simultaneous effects analysis reveals a path coefficient of 0.881, indicating a very strong positive combined influence when the three variables operate in an integrated manner. The sample mean (0.883) and very low standard deviation (0.036) demonstrate high stability and reliability of the parameter estimate across subsamples. The t-statistic (24.181) far exceeds the critical value of 1.96, and the p-value (0.000) confirms a highly significant effect at the 5% level. Therefore, H4 is accepted.

### Synergistic Effects: The Social Production of Operational Effectiveness

This section highlights the most strategic finding of the study, namely the emergence of a very strong synergistic effect when communication technology, personnel capability, and power system reliability are analyzed simultaneously. The structural modeling results indicate that, when treated as an integrated configuration, these three elements explain more than eighty percent of the variance in communication and electronics effectiveness. This finding marks an important shift in how operational effectiveness is conceptualized. Rather than being understood as a linear outcome of the mere presence or quality of technological infrastructure, effectiveness emerges as the product of dynamic interactions among human actors, technology, and the material conditions that sustain them (Verbong & Geels, 2007; Wibisono et al., 2024). In the context of border security operations in outermost regions, effectiveness therefore cannot be reduced to a technical issue; instead, it must be understood as a social process unfolding within complex organizational systems characterized by persistent constraints.

When examined in isolation, VSAT Manpack–based communication technology and power system reliability do not exhibit significant direct effects on operational effectiveness. However, this pattern changes fundamentally when these variables are situated within an interactional framework that includes personnel capability. In this configuration, technology and energy function as enabling structures, they provide potential but do not automatically generate performance. Such potential can only be realized through competent human action that is capable of interpreting situational demands, managing constraints, and integrating multiple resources into everyday operational practice. In other words, technology does not operate by itself; it is made to work. Its effectiveness depends on the ability of personnel to deploy it in a reflective and adaptive manner (Izuogu et al., 2025; Sulaiman, Y. B., et al., 2023).

Under conditions of geographical isolation and fragile infrastructure, such as those faced by outer island security task forces, personnel are often required to act as more than technical operators. They become critical intermediaries connecting communication systems, unstable energy supplies, and urgent operational demands. Field coordination, rapid decision-making, and the capacity for technical improvisation are essential to sustaining communication continuity. It is in this context that personnel capability functions as an integrative mechanism, binding technical and material elements into a coherent organizational practice. Operational effectiveness is thus produced through collective work involving situational learning, interpersonal trust, and practical knowledge accumulated through field experience.

These findings are consistent with contemporary developments in Socio-Technical Systems Theory, which emphasize that the performance of complex systems is not determined by the isolated optimization of technical components, but by the alignment of technical, social, and institutional elements (Balanzó-Guzmán & Ramos-Mejía, 2023; Sulaiman, S., et al., 2024). Within this updated theoretical perspective, technology is understood as part of a broader assemblage in which effectiveness depends on relationships among elements rather than on the intrinsic capacity of any single component. Ropohl, as reinterpreted within this framework, emphasizes that technical systems always presuppose systems of human action that provide meaning, direction, and purpose to technological use. Without such integration, technology tends to produce what appears as illusory modernization, physically present but functionally weak.

The synergistic effect identified in this study also highlights the critical role of power systems as a material precondition for the functioning of technology, even though this role is not always immediately visible. A reliable energy supply does not automatically enhance effectiveness; however, its unreliability can rapidly incapacitate communication systems and increase the workload of personnel. In such contexts, the ability of personnel to manage energy constraints, through strategies such as prioritizing device usage or maintaining backup systems, becomes an integral component of effectiveness production. Energy, technology, and human actors thus form interdependent relationships that can only be fully understood through a socio-technical lens (Arifin et al., 2024).

More broadly, these findings enrich the understanding of border security as a form of collective social practice. Security is not enacted solely through sophisticated equipment or formal procedures, but through coordinated work involving situational interpretation, interpersonal communication, and continuous adaptation to field conditions. Operational effectiveness emerges from an organization's capacity to align technology with human capability and existing structural conditions. This perspective challenges policy assumptions that position infrastructure investment as the primary solution and instead redirects attention toward the development of human capacity and organizational learning as the foundations of sustainable security.

## CONCLUSION

The conclusion of this study affirms that operational effectiveness in border security cannot be understood as a direct outcome of the presence or sophistication of communication infrastructure alone, but rather as the result of a socially mediated process shaped by personnel capability and supported by power system reliability. In line with the research objectives, the empirical findings demonstrate that personnel capability functions as the primary enabling force that activates and gives functional meaning to communication technology and energy infrastructure, while technology and power systems operate as enabling conditions whose effectiveness depends on their integration within competent and adaptive organizational practices. Accordingly, this study shows that operational effectiveness emerges from a synergistic socio-technical interaction rather than from linear, infrastructure-driven investment, particularly in geographically isolated and structurally vulnerable border regions. The novelty of this research lies in its shift away from technologically deterministic approaches toward a sociological perspective that centers human agency and organizational capacity in the production of security performance, thereby contributing empirical insight from peripheral state spaces in the Global South to broader debates in social and political science without overstating technology as a singular solution to border governance challenges.

## ETHICAL STATEMENT AND DISCLOSURE

This study was conducted in accordance with established ethical principles, including informed consent, protection of informants' confidentiality, and respect for local cultural values. Special consideration was given to participants from vulnerable groups to ensure their

safety, comfort, and equal rights to participate. No external funding was received, and the authors declare no conflict of interest. All data and information presented were collected through valid research methods and have been verified to ensure their accuracy and reliability. The use of artificial intelligence (AI) was limited to technical assistance for writing and language editing, without influencing the scientific substance of the work. The authors express their gratitude to the informants for their valuable insights, and to the anonymous reviewers for their constructive feedback on an earlier version of this manuscript. The authors take full responsibility for the content and conclusions of this article.

## REFERENCES

Arifin, R., Zulfa, E. A., Hanita, M., & Simon Runturambi, A. J. (2024). Unveiling Indonesia's migration and border governance: Challenges and imperatives post-pandemic. *Social Sciences & Humanities Open*, *10*(2), 101202. https://doi.org/10.1016/j.ssaho.2024.101202

Balanzó-Guzmán, A., & Ramos-Mejía, M. (2023). Towards epistemic diversity in sustainability transitions: an exploration of hybrid socio-technical systems. *Sustainability Science*, *18*(6), 2511–2531. https://doi.org/10.1007/s11625-023-01370-9

Bangun, B. H., Kinanti, F. M., & Darajati, M. R. (2024). Economic Security in Border Areas: The Fulfillment of Community Welfare. *Lampung Journal of International Law*, *6*(2), 69–82. https://doi.org/10.25041/lajil.v6i2.3355

Bharoto, B., Hanan, H., & Widyowijatnoko, A. (2025). Institutionalising concrete construction technology: A socio-technical formation of modern architecture in Indonesia. *History of Science and Technology*, *15*(2), 396. https://doi.org/10.32703/2415-7422-2025-15-2-396-425

Caruso, G., de Marcos, I., & Noy, I. (2024). Climate Changes Affect Human Capital. *Economics of Disasters and Climate Change*, *8*(1), 157–196. https://doi.org/10.1007/s41885-023-00140-2

Chang, Y.-H., Silalahi, A. D. K., Eunike, I. J., & Riantama, D. (2024). Socio-technical systems and trust transfer in live streaming e-commerce: analyzing stickiness and purchase intentions with SEM-fsQCA. *Frontiers in Communication*, *9*(2), 5409. https://doi.org/10.3389/fcomm.2024.1305409

Coupet, E. (2025). Is There a Demand Pull or Supply Push Between Southwest Border Apprehensions and Employment in the United States? *International Journal of Economics, Business and Management Research*, *09*(01), 210–225. https://doi.org/10.51505/IJEBMR.2025.9115

Emmanuel, J., Retno, H. W., & Yuliar, S. (2023). Innovation as A Socio-Technical Transition: The Case of Digital Transportation Service Platforms in Indonesia. *STI Policy and Management Journal*, *8*(1), 59–72. https://doi.org/10.14203/STIPM.2023.362

Fathoni, F., Lovett, J. C., & Rifansha, M. M. (2025). A Multi-Level Perspective on Transition to Renewable Energy in the Indonesian Transport Sector. *Energies*, *18*(21), 5723. https://doi.org/10.3390/en18215723

Freitas, F., Zimmermann, R., Freires, G., Couto, F., Fontes, C., Soares, A. L., Dalmarco, G., Rhodes, D., & Gomes, J. (2025). Socio-Technical AI Maturity in Supply Chains: Insights from the Pulp and Paper Sector. In *Hybrid Human-AI Collaborative Networks* (pp. 169–184). https://doi.org/10.1007/978-3-032-05673-3_11

García-Collado, A., Dorado-Vicente, R., Romero, P. E., & Gupta, M. K. (2023). Recent Trends on the Mechanical Properties of Additive Manufacturing. *Applied Sciences*, *13*(12), 7067. https://doi.org/10.3390/app13127067

Harianja, T. D. N. R. (2025). Building Consumer Loyalty: The Role of Product Quality and Price in Purchase Decisions of Brand Executive in South Tangerang. *Baileo: Jurnal Sosial Humaniora*, *2*(3), 305–319. https://doi.org/10.30598/baileofisipvol2iss3pp305-319

Hieng, B. B., & Prabawati, N. P. A. (2024). Digital Transformation in Villages: A Policy Implementation Approach in Kajowair Village, Nusa Tenggara Timur. *Baileo: Jurnal Sosial Humaniora*, *2*(2), 189–198. https://doi.org/10.30598/baileofisipvol2iss2pp189-198

Izuogu, K. C., Okpara, O., & Omeonu, D. U. (2025). The Paradox of The Internet in Journalism in Nigeria: Between Flexibility and Accuracy Challenges. *Baileo: Jurnal Sosial Humaniora*, *2*(2), 256–267. https://doi.org/10.30598/baileofisipvol2iss2pp256-267

Jahanger, A. (2022). Impact of globalization on CO2 emissions based on EKC hypothesis in developing world: the moderating role of human capital. *Environmental Science and Pollution Research*, *29*(14), 20731–20751. https://doi.org/10.1007/s11356-021-17062-9

Karakurt, I. (2021). Modelling and forecasting the oil consumptions of the BRICS-T countries. *Energy*, *220*(3), 119720. https://doi.org/10.1016/j.energy.2020.119720

Komalasari, R., & Mustafa, C. (2024). An Analysis of Foreign Direct Investment, Human Capital Dynamics, and Policy Imperatives in Indonesia and ASEAN. *Jurnal Politica Dinamika Masalah Politik Dalam Negeri Dan Hubungan Internasional*, *15*(1), 57–79. https://doi.org/10.22212/jp.v15i1.4172

Kurniawan, V. A., Pradheksa, P. Y., & Saleh, R. (2024). The failure of micro-hydro technology: A case study of the Banyubiru project in Central Java, Indonesia. *Renewable and Sustainable Energy Transition*, *5*(4), 100081. https://doi.org/10.1016/j.rset.2024.100081

Latuheru, M. S., Manuputty, F., & Angkotasan, S. (2024). Interactions Between Generations in Digital Literacy Education: A Case of Millennial Families in Suli, Central Maluku. *Baileo : Jurnal Sosial Humaniora*, *1*(2), 141–154. https://doi.org/10.30598/baileofisipvol1iss2pp141-154

Lehmann, R., & Wiertz, T. (2025). 'Green tech' geographies: The role of technology in contemporary frontier-making processes. *Environment and Planning C: Politics and Space*, *9*(9), 84103. https://doi.org/10.1177/23996544251384103

Majdi, M. A., Zulfa, E. A., & Handayani, R. S. (2025). Spatial Approach in Optimizing Human Resources of Immigration PPNS for Organizational Resilience in Immigration Law Enforcement. *Eduvest - Journal of Universal Studies*, *5*(6), 6576–6585. https://doi.org/10.59188/eduvest.v5i6.50783

Mayndarto, E. C. (2025). Big Data Analytics Capabilities and Firm Competitiveness in The Digital Age: A Socio-Economic Perspective from Emerging Markets. *Baileo: Jurnal Sosial Humaniora*, *2*(3), 382–399. https://doi.org/10.30598/baileofisipvol2iss3pp382-399

Mustika, A. C., & Indrady, A. (2024). Implementation of Immigration Functions in Border Areas Based on Human Security Perspective. *Asian Journal of Engineering, Social and Health*, *3*(5), 1110–1117. https://doi.org/10.46799/ajesh.v3i5.327

Polnaya, T., Murwani, P., & D. Pariela, T. (2023). Cultural Transformation and Social Interaction in Indigenous Communities: The Impact of Digital Technology. *Baileo : Jurnal Sosial Humaniora*, *1*(1), 1–14. https://doi.org/10.30598/baileofisipvol1iss1pp1-14

Pradita, R. I. (2025). Navigating Maritime Digitalization: Socioeconomic and Organizational Perspectives on Technological Transformation. *Baileo: Jurnal Sosial Humaniora*, *2*(3), 320–333. https://doi.org/10.30598/baileofisipvol2iss3pp320-333

Pradnyani, I. G. A. A. D. R., & Prabawati, N. P. A. (2025). Sociotechnocracy in Job Training

Governance: A Reflection on E-Government Practices at UPTD BLKIP Bali. *Baileo: Jurnal Sosial Humaniora*, *2*(3), 431–448. https://doi.org/10.30598/baileofisipvol2iss3pp431-448

Rahim, D. A., Kasikoen, K. M., Supartoyo, Y. H., & Setiawan, S. (2024). Infrastructure Development in Border Areas; Who Benefits? *International Journal of Sustainable Development and Planning*, *19*(07), 2771–2777. https://doi.org/10.18280/ijsdp.190734

Ravlinko, Z., Shliakhetko, V., Motorniuk, U., Petrukha, N., & Pawera, R. (2023). Formation, development and use of human capital: aspects of personnel security in a military conflict. *International Journal of Services, Economics and Management*, *14*(4), 452–466. https://doi.org/10.1504/IJSEM.2023.134125

Risal, S., Irawanto, I., Hergianasari, P., Rahma, A. A., & Pramudiana, I. D. (2022). Border Development Model on the Human Development Aspects for Sustainable Community. *Jurnal Borneo Administrator*, *18*(2), 125–138. https://doi.org/10.24258/jba.v18i2.971

Salsinha, L. M. D. S., & Lukman, J. P. (2024). Library Digitalization and Modernization: Strategies for Utilizing E-Clipping to Enhance Services at The Digital Library of The Audit Board of The Republic of Indonesia (BPK RI) Bali Provincial Office. *Baileo: Jurnal Sosial Humaniora*, *2*(2), 176–188. https://doi.org/10.30598/baileofisipvol2iss2pp176-188

Septiari, N. K. R., & Prabawati, N. P. A. (2025). From Regulation to Realization: A Sociotechnical Study on the Implementation of SIAPKerja in the Work Training Unit of Bali Province. *Baileo: Jurnal Sosial Humaniora*, *2*(3), 416–430. https://doi.org/10.30598/baileofisipvol2iss3pp416-430

Setyadi, A., Pawirosumarto, S., & Damaris, A. (2025). Embedding Circular Operations in Manufacturing: A Conceptual Model for Operational Sustainability and Resource Efficiency. *Sustainability*, *17*(15), 6737. https://doi.org/10.3390/su17156737

Setyadi, A., Pawirosumarto, S., Damaris, A., & Syarif, D. (2025). Integrating green HRM and sustainable operations: the moderating role of digital transformation in the Indonesian energy sector. *Discover Sustainability*, *6*(1), 924. https://doi.org/10.1007/s43621-025-01764-y

Shao, S., & Razzaq, A. (2022). Does composite fiscal decentralization reduce trade-adjusted resource consumption through institutional governance, human capital, and infrastructure development? *Resources Policy*, *79*(12), 103034. https://doi.org/10.1016/j.resourpol.2022.103034

Sinaga, C. Y., Watloly, A., & Litaay, S. C. H. (2024). The Communication Patterns Between Parents And Migrant Children in The Digital Era: Strengthening Emotional Connections Through Technology. *Baileo: Jurnal Sosial Humaniora*, *2*(1), 27–38. https://doi.org/10.30598/baileofisipvol2iss1pp27-38

Siregar, K. C., Sopacua, Y., & Alfredo, R. (2024). Digital Revolution In Public Communication Management: A Review Of Opportunities And Challenges For Maluku Regional Police Public Relations In The Digital Era. *Baileo: Jurnal Sosial Humaniora*, *1*(3), 244–255. https://doi.org/10.30598/baileofisipvol1iss3pp244-255

Sulaiman, Y. Bin, Lestaluhu, S., & Husein, M. I. (2023). The Phenomenon of Augmented Reality Face Filter Usage on Instagram Among Communication Science Students of the 2019 Cohort at Pattimura University, Ambon. *Baileo : Jurnal Sosial Humaniora*, *1*(1), 40–52. https://doi.org/10.30598/baileofisipvol1iss1pp40-52

Sulaiman, S., Trimawarni, A., Wahyuni, E., & Listiana, Y. D. (2024). Toward A Smart City Pontianak: A Study of Digital Governance Effectiveness As A Moderator of The Relationship Between Work Culture, HR Management, and Public Satisfaction. *Baileo:*

*Jurnal Sosial Humaniora*, *2*(2), 120–129. https://doi.org/10.30598/baileofisipvol2iss2pp120-129

Verbong, G., & Geels, F. (2007). The ongoing energy transition: Lessons from a socio-technical, multi-level analysis of the Dutch electricity system (1960–2004). *Energy Policy*, *35*(2), 1025–1037. https://doi.org/10.1016/j.enpol.2006.02.010

Wibisono, H., Lovett, J., Chairani, M. S., & Suryani, S. (2024). The ideational impacts of Indonesia’s renewable energy project failures. *Energy for Sustainable Development*, *83*(4), 101587. https://doi.org/10.1016/j.esd.2024.101587