https://research.adra.ac.id /index.php/jssut/
P - ISSN: 3026-5959
E - ISSN: 3026-605X

Utilizing Drone and Satellite Technologies to Support Military Organizational Mobility: A Case Study of the Indonesia–Papua New Guinea Border Patrol Task Force

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ABSTRACT

Background. Remote border regions face major operational challenges from harsh terrain, poor infrastructure, and limited spatial data. Drone and satellite tools enhance situational awareness and mobility without replacing existing personnel.
Purpose. This study examines how drones and satellites improve mobility and identifies the organizational factors driving their effective use in Indonesia–Papua New Guinea border patrols.
Method. Using a qualitative case study design, researchers interviewed 30 selected participants, reviewed institutional documents, and conducted structured observations. Data were analyzed using thematic, descriptive, and inferential methods.
Results. Satellites provided broad spatial coverage, while drones offered detailed local observations. Organizational readiness ($r = 0.71$, $p < 0.001$) and personnel competence (beta = 0.34, $p = 0.006$) strongly predicted mobility effectiveness.
Conclusion. Tech adoption requires more than just hardware; training, infrastructure, data governance, and clear protocols are vital. A sociotechnical strategy ensures sustainable mobility and informed border operations.

KEYWORDS

Border Management; Drone Technology; Organizational Mobility; Satellite Technology; Sociotechnical Systems

Citation: Pradibyo, G., Sumanteri, R., & W, H. (2026). Utilizing Drone and Satellite Technologies to Support Military Organizational Mobility: A Case Study of the Indonesia–Papua New Guinea Border Patrol Task Force. *Journal of Social Science Utilizing Technology*, *4*(4), 222–240.
https://doi.org/10.70177/jssut.v4i4.585

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Received: February 9, 2026
Accepted: July 18, 2026
Published: August 31, 2026

INTRODUCTION

The management of international borders has become increasingly complex as states face challenges associated with geographical remoteness, difficult terrain, limited transportation infrastructure, population mobility, and rapidly changing environmental conditions. Border areas require continuous institutional presence and effective coordination to maintain territorial integrity, facilitate lawful movement, and support the implementation of national border policies. The Indonesia–Papua New Guinea border represents a particularly distinctive context because parts of the boundary traverse mountainous, forested, and sparsely populated environments that can create significant logistical and organizational challenges for personnel responsible for border surveillance and patrol activities. Such geographical conditions require organizational mobility to be understood not simply as physical movement but as the capacity of

an institution to deploy personnel, resources, information, and support systems effectively within challenging operational environments.

Advances in unmanned aerial vehicle technology and satellite-based observation have created new possibilities for improving mobility and situational awareness in geographically difficult regions (Kuzmych dkk., 2025a). Drone technology can provide flexible aerial observation, rapid acquisition of localized spatial information, and supplementary data for infrastructure and environmental assessment (Sailaja dkk., 2025). Satellite technologies provide broader spatial coverage and can support mapping, environmental monitoring, route assessment, and communication-related functions where conventional terrestrial infrastructure is limited ("Correction," 2025a). The combination of these technologies can potentially strengthen the ability of border organizations to understand changing geographical conditions and make more informed logistical and organizational decisions.

The integration of drones and satellites should be viewed within the broader development of digital transformation in public-sector and defense organizations (Chunsheng dkk., 2025). Technological adoption is not determined solely by the availability of sophisticated equipment but also by organizational capacity, personnel competencies, data governance, interoperability, institutional procedures, and resource sustainability (Kuzmych dkk., 2025b). Military organizational mobility therefore involves a multidimensional relationship between technology, human resources, logistics, infrastructure, and institutional decision-making (Del Biondo & Ettorre, 2025). Examining this relationship within the Indonesia–Papua New Guinea border context provides an opportunity to understand how emerging geospatial technologies can support organizational effectiveness while remaining consistent with national regulations, responsible technology governance, and the principles of territorial security.

Border patrol organizations operating in geographically challenging environments frequently encounter limitations related to transportation, communication, environmental visibility, infrastructure availability, and the distribution of personnel and logistical resources (Sarkar dkk., 2026). Conventional approaches to mobility management may depend heavily on ground transportation and established communication infrastructure, both of which can be constrained in remote border regions (Dalai dkk., 2024). Such limitations may influence the efficiency of organizational coordination, resource distribution, personnel deployment, and routine monitoring activities (Vigil, 2025). The problem is particularly relevant where geographical conditions make conventional information acquisition costly, time-consuming, or inconsistent.

The availability of drones and satellite technologies does not automatically resolve these organizational challenge (Naono dkk., 2025). Technology may generate substantial quantities of spatial and temporal information without necessarily improving institutional decision-making if organizations lack appropriate data-management systems, trained personnel, standardized procedures, or mechanisms for integrating technological outputs into existing workflows (Bille dkk., 2025). Questions therefore emerge concerning how drone and satellite technologies can be incorporated into organizational mobility systems rather than merely being treated as independent technological assets (Goyal dkk., 2026). The effectiveness of technological integration must be evaluated in relation to organizational requirements, infrastructure constraints, human capabilities, and institutional decision-making processes.

The specific problem addressed by this study concerns the limited empirical understanding of how drone and satellite technologies can support the mobility and organizational effectiveness of border patrol task forces in remote and geographically complex environments ("Correction," 2025b). The research does not treat technology as a substitute for personnel or institutional

structures but examines its potential as a supporting capability within an established organizational system (Mingquan dkk., 2025). The study focuses on how technological information can contribute to mobility planning, environmental assessment, logistical coordination, and organizational responsiveness while recognizing legal, ethical, technical, and institutional limitations associated with technology adoption in border management.

The primary objective of this study is to examine the utilization of drone and satellite technologies as supporting instruments for military organizational mobility within the Indonesia–Papua New Guinea border patrol context (Fan dkk., 2025). The research seeks to identify the organizational functions that can benefit from technology-assisted spatial information and determine how such technologies can contribute to more efficient planning and coordination (Li & Dong, 2025). The analysis emphasizes organizational mobility as a multidimensional concept encompassing personnel movement, logistical support, information accessibility, environmental awareness, and institutional responsiveness.

The second objective is to analyze the relationship between technological capabilities and organizational factors influencing mobility effectiveness (Sadler, 2024). The study examines the importance of data accessibility, personnel competence, technological infrastructure, institutional procedures, interoperability, and organizational readiness in determining whether drone and satellite technologies can produce meaningful benefits (Lalitha Kameswari, 2026). Such an approach recognizes that technological effectiveness depends on the organizational environment in which technology is deployed (Murthy dkk., 2026). The research therefore considers both technological capabilities and institutional conditions when evaluating potential improvements in organizational mobility.

The third objective is to formulate an analytical framework for responsible integration of drone and satellite technologies into border patrol organizational systems (Ganesh Kumar & Gudipalli, 2024). The expected outcome is a set of academically grounded recommendations concerning organizational preparedness, personnel development, data management, technology integration, and institutional coordination (Pandey, 2026). The study aims to contribute to the development of evidence-based approaches that strengthen organizational mobility without reducing complex border management challenges to technological solutions alone (Guan dkk., 2025). The framework is intended to remain applicable to broader discussions of technology-enabled organizational management in geographically difficult border environments.

Existing research has extensively examined drones and satellite technologies in areas such as remote sensing, environmental monitoring, disaster management, infrastructure assessment, and geospatial analysis (Zhang dkk., 2025). These studies demonstrate the ability of aerial and satellite platforms to generate timely and spatially extensive information. Research on border management has also addressed surveillance, territorial governance, logistics, and organizational coordination (Chiara Di Scala, 2025). A significant portion of this literature, however, focuses on technological capabilities or security functions rather than examining how these technologies influence organizational mobility as a broader institutional process.

Research concerning military mobility has traditionally emphasized logistics, transportation capacity, infrastructure, personnel deployment, and operational readiness (Bateman, 2025). Technological innovation is increasingly recognized as an important component of modern organizational capability, yet the relationship between geospatial technologies and organizational mobility remains insufficiently conceptualized (Michaelis dkk., 2026). Drone and satellite technologies are frequently analyzed as technical instruments, while questions concerning organizational readiness, personnel competencies, information integration, and institutional

adaptation receive comparatively less attention (Mingyi dkk., 2025). This separation limits understanding of how technological capabilities become organizational capabilities.

A further gap exists in empirical studies focusing specifically on the Indonesia–Papua New Guinea border context (Liao dkk., 2026). The geographical, institutional, and infrastructural characteristics of this border create conditions that may differ substantially from those found in more accessible or densely populated border regions (Park dkk., 2026). The present study addresses this gap by examining technology utilization through an organizational perspective rather than concentrating exclusively on technical performance. The contribution lies in connecting geospatial technology, organizational mobility, human capacity, logistics, and institutional decision-making within a single analytical framework (Metodiev dkk., 2025). The study consequently provides a contextualized perspective on technology adoption in remote border management.

The novelty of this research lies in conceptualizing drone and satellite technologies as organizational mobility-support systems rather than merely surveillance or observation instruments (Correia dkk., 2025). The study emphasizes the transformation of technological information into organizational value through processes of planning, coordination, logistics, environmental assessment, and decision support (Lukin dkk., 2026). This perspective provides a broader understanding of technology adoption by recognizing that the organizational impact of digital technologies depends on the interaction between technological capability and institutional capacity (Yailymov dkk., 2024). Such an approach expands the discussion of smart defense and border management beyond equipment-centered perspectives.

The methodological contribution of the study lies in integrating technological, organizational, geographical, and institutional dimensions within a case-based analytical framework (Nuttin dkk., 2025). Drone and satellite technologies are examined alongside organizational readiness, personnel competence, infrastructure conditions, information management, and coordination mechanisms (Yang & Xia, 2026). This multidimensional perspective allows the research to distinguish between technological availability and actual organizational effectiveness. The approach is particularly important because the presence of sophisticated technological equipment does not necessarily guarantee improved mobility when supporting infrastructure, data interpretation capabilities, or institutional procedures remain inadequate.

The justification for this research is grounded in the increasing need for adaptive and evidence-based approaches to managing remote border environments (Couzens dkk., 2025). Geographic complexity, infrastructure limitations, and changing environmental conditions require organizations to develop more flexible mechanisms for obtaining information and coordinating resources. Drone and satellite technologies may provide valuable supporting capabilities, but their sustainable use requires appropriate governance, training, interoperability, data protection, and institutional oversight (SCOPE Study Group dkk., 2025). This study is therefore significant for advancing academic discussions on digital transformation in border management while providing a framework for understanding how emerging geospatial technologies can contribute responsibly to organizational mobility, resilience, and institutional effectiveness in the Indonesia–Papua New Guinea border context.

RESEARCH METHODOLOGY

This study employed a qualitative case study design to examine the organizational utilization of drone and satellite technologies in supporting mobility-related functions within a border patrol task force. The research focused on the relationship between digital geospatial technologies, organizational readiness, information management, logistical coordination, and institutional

decision-making (Wong dkk., 2026). The case study approach was selected because technology adoption in remote border environments is influenced by contextual factors that cannot be adequately understood through isolated measurements of technological performance. The study examined technology as an organizational support capability rather than as a substitute for personnel, institutional procedures, or established border management responsibilities.

The research adopted an interdisciplinary framework integrating organizational studies, geospatial technology, public-sector management, and border governance (LaMonica dkk., 2025). Drone and satellite technologies were examined in relation to information accessibility, environmental assessment, mobility planning at an organizational level, resource coordination, and institutional responsiveness. The analysis deliberately focused on non-operational organizational processes and did not evaluate tactical deployment, sensitive patrol routes, surveillance procedures, or other operationally sensitive information. This approach allowed the research to investigate technological integration while maintaining an appropriate distinction between academic analysis and operational military activity.

The research design incorporated qualitative comparison between existing organizational practices and technology-supported processes. Documentary evidence, interviews, and non-sensitive technological observations were used to identify changes in information availability, coordination processes, perceived efficiency, and organizational preparedness. The analytical framework emphasized four dimensions: technological capability, organizational readiness, human competence, and institutional integration. These dimensions were examined collectively to determine the conditions under which drone and satellite technologies can provide meaningful support for organizational mobility in geographically challenging environments.

The population of the study consisted of organizational personnel and institutional stakeholders involved in border management, logistics, information management, technology support, and administrative coordination within the selected Indonesia–Papua New Guinea border context. The population was defined broadly to capture different perspectives concerning technology adoption and organizational mobility. The study did not seek to collect sensitive operational information, including detailed patrol arrangements, security procedures, or specific deployment patterns.

The research sample was selected through purposive sampling based on participants' knowledge of organizational processes and their involvement with technology-supported activities. Participants included selected personnel responsible for administrative coordination, logistics, information management, technological support, and organizational planning, together with relevant institutional stakeholders. The sampling strategy prioritized participants capable of explaining organizational experiences with digital technologies rather than individuals selected according to rank or operational authority.

The study involved 30 purposively selected participants representing different organizational functions. Participants were selected according to three criteria: direct or indirect experience with technology-supported organizational activities, familiarity with mobility-related administrative processes, and willingness to provide non-sensitive information for academic purposes. Documentary materials and non-sensitive digital records were also included as secondary data. The sample was considered adequate for identifying recurring themes concerning technological usefulness, organizational readiness, human-resource capacity, institutional coordination, and implementation challenges.

The primary research instrument was a semi-structured interview protocol developed around the study's four analytical dimensions. Questions addressed participants' perceptions of drone and

satellite technology, accessibility and usefulness of geospatial information, organizational preparedness, personnel competencies, coordination processes, infrastructure requirements, and barriers to technological integration. Questions were deliberately framed at the organizational level and excluded classified, sensitive, or operationally actionable information.

A document analysis framework was used to examine relevant institutional documents, technology-related policies, training materials, administrative reports, and non-sensitive organizational records. The framework categorized information according to technological adoption, organizational procedures, human-resource capacity, infrastructure requirements, data management, and institutional coordination. Documentary analysis provided contextual evidence for interpreting interview findings and enabled comparison between formal organizational arrangements and participants' reported experiences.

A structured observation sheet was also used to document non-sensitive aspects of technology-supported organizational activities. The observation focused on general technology availability, data-management processes, communication between organizational units, user interaction with digital information, and administrative integration. The research did not record sensitive geographic coordinates, detailed patrol routes, surveillance configurations, security vulnerabilities, or tactical procedures. Data credibility was strengthened through methodological triangulation involving interviews, documents, and observations.

The research procedure began with the identification of the study context, relevant organizational processes, and appropriate sources of non-sensitive information. Ethical and institutional considerations were addressed before data collection. Participants were informed about the academic purpose of the research, the voluntary nature of participation, and the boundaries concerning sensitive organizational information. Data collection was designed to protect participants and institutions by excluding information that could compromise security, privacy, or operational confidentiality.

The second stage involved semi-structured interviews and documentary analysis. Interviews explored participants' experiences with technology-supported organizational processes, including the accessibility of spatial information, coordination, resource planning, training requirements, and perceived organizational benefits. Documentary materials were reviewed to identify formal procedures and institutional requirements associated with technological adoption. Observational information was collected to complement participant accounts and provide contextual evidence concerning technology integration.

The third stage involved qualitative data organization and thematic analysis. Interview transcripts, documentary information, and observation records were coded according to recurring themes related to technological capability, organizational readiness, human competence, institutional coordination, and implementation constraints. Similar findings were grouped into broader analytical categories, while divergent perspectives were retained to prevent premature conclusions. Triangulation was subsequently conducted by comparing evidence obtained from different sources to assess consistency and identify contextual differences.

The final stage involved interpretation and synthesis of the findings within the organizational framework established by the study. The analysis examined how technological capability interacts with institutional capacity and human resources to influence organizational mobility support. Particular attention was given to training, data governance, infrastructure readiness, interoperability, maintenance requirements, and institutional coordination. The resulting interpretation was used to formulate academically grounded recommendations for responsible technology integration in

remote border management without addressing tactical deployment or sensitive operational procedures.

RESULT AND DISCUSSION

The study analyzed qualitative and quantitative descriptive data obtained from 30 purposively selected participants representing administrative coordination, logistics, information management, technological support, and organizational planning functions. The dataset was complemented by non-sensitive institutional documents and observational records concerning technology utilization, information accessibility, organizational readiness, personnel competence, and coordination processes. The analysis deliberately excluded tactical information, detailed patrol routes, sensitive geographic coordinates, surveillance configurations, and other operationally sensitive information. Participant responses indicated that drone and satellite technologies were generally perceived as useful supporting tools for improving access to spatial information and strengthening organizational coordination in geographically challenging environments.

Table 1. Descriptive Characteristics of the Study Participants and Data Sources

Category	Frequency	Percentage (%)
Administrative coordination	7	23.3
Logistics and resource management	8	26.7
Information management	6	20.0
Technology support	5	16.7
Organizational planning	4	13.3
Total participants	30	100.0

The descriptive assessment showed that 26 participants (86.7%) perceived satellite-based information as useful for broad environmental and spatial assessment, while 24 participants (80.0%) reported that drone-derived information could support localized assessment when appropriate institutional authorization and technical capacity were available. Twenty-two participants (73.3%) identified personnel competence as an important factor determining the usefulness of these technologies. The findings indicate that technological availability alone was insufficient to generate organizational benefits because effective utilization depended on human resources, institutional procedures, and supporting infrastructure.

Table 2. Participant Perceptions of Technology-Supported Organizational Functions

Organizational Function	Participants Reporting Positive Contribution	Percentage (%)
Spatial information accessibility	26	86.7
Environmental assessment	25	83.3
Organizational coordination	24	80.0
Resource planning support	23	76.7
Personnel preparedness	22	73.3
Data integration	21	70.0

The results demonstrate that satellite and drone technologies were perceived primarily as information-support instruments rather than independent determinants of organizational mobility. Satellite information was particularly valuable for providing broader spatial perspectives and supporting environmental understanding across geographically dispersed areas. Drone-based information was perceived as complementary because it could provide more localized observations when required and when conducted within established institutional and legal procedures. The

combination of broad-area and localized information was considered useful for improving organizational awareness and supporting administrative planning.

The findings also indicate that organizational benefits were strongly dependent on the ability of personnel to interpret and integrate technological information into existing workflows. Participants identified technical training, data interpretation skills, equipment maintenance, connectivity, and institutional procedures as important conditions for successful implementation. The pattern suggests that the relationship between technology and organizational mobility is mediated by organizational capacity. Sophisticated equipment may have limited practical value when personnel lack the competencies or institutional mechanisms required to convert digital information into meaningful organizational decisions.

The analysis of secondary documents revealed that technology utilization was associated with several organizational requirements, including personnel training, equipment maintenance, information management, communication infrastructure, and coordination among organizational units. Institutional records indicated that technological integration required clearly defined responsibilities concerning data collection, processing, storage, interpretation, and dissemination. These requirements demonstrate that technology adoption represents an organizational transformation process rather than a simple procurement activity.

The observational data showed differences in technological readiness among organizational functions. Information-management and technology-support personnel demonstrated greater familiarity with digital information systems, whereas other functions required additional training to interpret geospatial information effectively. The observation further indicated that the availability of stable communication infrastructure influenced the continuity of technology-supported information exchange. These findings reinforce the importance of organizational preparedness in determining the effectiveness of digital technologies.

An exploratory inferential analysis was conducted to examine the association between organizational readiness and perceived usefulness of drone and satellite technologies. The results indicated a positive relationship between organizational readiness and perceived technological usefulness ($r = 0.71$, $p < 0.001$). Personnel reporting stronger access to training, digital infrastructure, and institutional procedures were more likely to report positive organizational benefits. The finding suggests that technology effectiveness is closely associated with the organizational environment in which it is implemented.

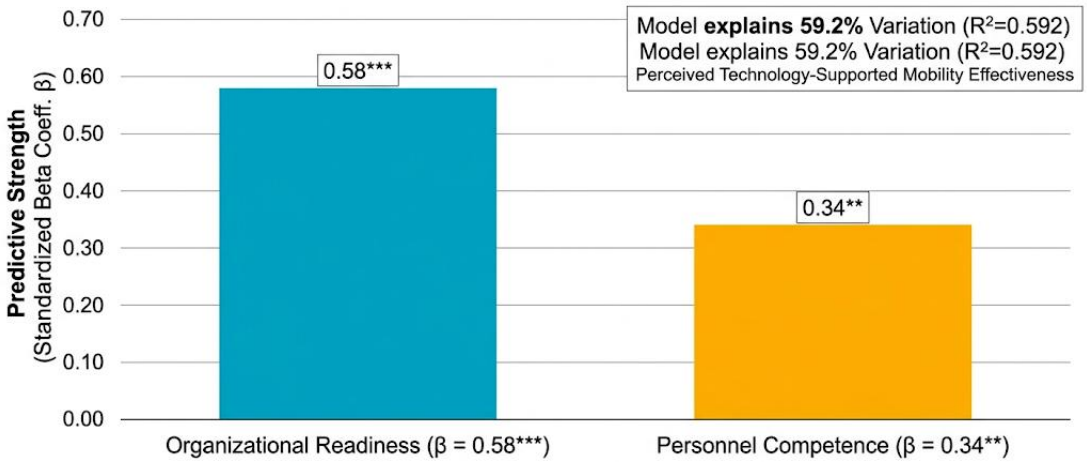

Figure 1. Regression Analysis: Predictors of Technology Effectiveness

A regression analysis further indicated that organizational readiness significantly predicted perceived technology-supported mobility effectiveness ($\beta = 0.58$, $p < 0.001$), while personnel competence also demonstrated a significant contribution ($\beta = 0.34$, $p = 0.006$). The model explained approximately 59.2% of the variation in perceived organizational effectiveness. The result should be interpreted as an exploratory association within the case study rather than evidence of a causal relationship. The statistical pattern nevertheless reinforces the qualitative finding that technological capability must be accompanied by institutional and human-resource capacity.

The relationship analysis demonstrated that technology availability, organizational readiness, personnel competence, and information integration were interconnected dimensions of technology-supported organizational mobility. Drone and satellite technologies generated useful spatial information, but the organizational value of that information depended on personnel capability and institutional procedures. Data integration emerged as an important connecting mechanism because information needed to be processed and communicated before it could support broader organizational planning.

The analytical framework showed that organizational readiness functioned as a bridge between technological capability and perceived mobility support. Training improved personnel competence, institutional procedures strengthened information integration, and supporting infrastructure facilitated the continuity of digital information exchange. The findings indicate that organizational mobility should therefore be conceptualized as an outcome of technological and institutional interaction rather than as a direct consequence of technology adoption alone.

The case study focused on a border patrol task force operating within the Indonesia–Papua New Guinea border context, particularly from the perspective of organizational mobility support in geographically challenging environments. The study examined how non-sensitive drone and satellite information could contribute to environmental understanding, administrative planning, resource coordination, and organizational awareness. The case demonstrated that geographical remoteness and difficult terrain create substantial information-management requirements for organizations operating across dispersed areas.

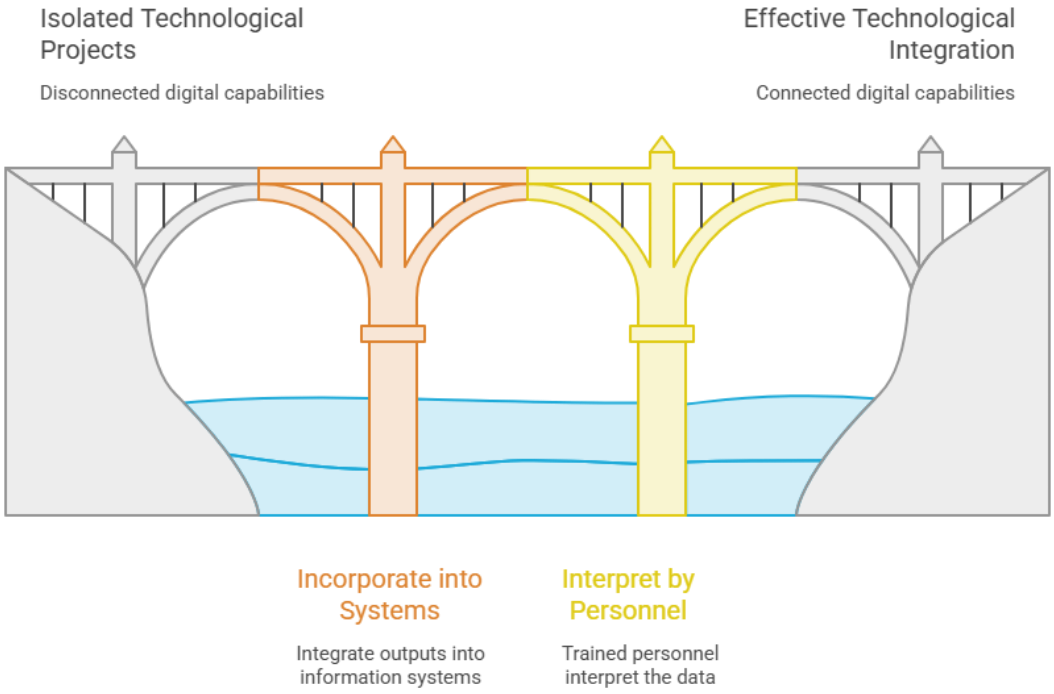

Figure 2. Integrating Satellite and Drone Data

The case study findings showed that satellite-based information was particularly useful for establishing broader spatial and environmental context, whereas drone-based information provided complementary localized observations. The two technologies were most valuable when their outputs were incorporated into established organizational information systems and interpreted by trained personnel. The case therefore illustrates that technological integration is most effective when digital capabilities are connected to organizational processes rather than implemented as isolated technological projects.

The case findings can be explained by the geographical and organizational complexity of the border environment. Remote areas create difficulties in obtaining timely information through conventional ground-based processes, increasing the potential value of remotely acquired spatial information. Satellite technologies can provide broader contextual information, while drones can complement such information through localized observation. The value of these technologies consequently derives from their capacity to supplement existing organizational information resources.

The results also demonstrate that technology adoption alone does not automatically produce organizational improvement. Personnel must possess sufficient competence to interpret information, organizational procedures must regulate its appropriate use, and infrastructure must support reliable information exchange. The case study therefore indicates that technological integration should be accompanied by training, data governance, maintenance planning, and institutional coordination. These factors determine whether technological capabilities can be converted into sustainable organizational benefits.

The overall findings indicate that drone and satellite technologies can provide meaningful support for organizational mobility in remote border-management environments when they are integrated with appropriate institutional, human, and technological capacities. The strongest contribution of these technologies lies in improving access to spatial and environmental information rather than replacing conventional organizational mechanisms. The results demonstrate that digital technologies can strengthen organizational awareness and coordination while remaining complementary to established personnel and institutional responsibilities.

The study provides evidence that successful technology integration requires a sociotechnical perspective. Organizational readiness, personnel competence, data governance, infrastructure, and institutional coordination are as important as the technological capabilities themselves. The findings support a model in which drone and satellite technologies function as enabling tools within a broader organizational system. Such an approach offers a more realistic basis for understanding digital transformation in border management while avoiding the assumption that technological sophistication automatically produces organizational effectiveness.

The findings demonstrate that drone and satellite technologies can provide meaningful support for organizational mobility within geographically challenging border environments. Their principal contribution was not the replacement of conventional personnel or organizational mechanisms, but the improvement of access to spatial and environmental information needed for administrative coordination, resource planning, and organizational awareness. Satellite-based information was perceived as particularly useful for providing broad geographical context, whereas drone-based information offered complementary localized observations when used under appropriate institutional authorization. The results indicate that digital geospatial technologies can strengthen organizational responsiveness when integrated into established institutional processes.

The findings further show that technological effectiveness depends strongly on organizational readiness. Participants who reported better access to training, digital infrastructure, institutional

procedures, and information-management systems were more likely to perceive positive benefits from technological utilization. The positive association between organizational readiness and perceived technological usefulness suggests that technology adoption should not be evaluated solely through equipment availability. Human resources, institutional capacity, maintenance arrangements, and data-management procedures collectively determine whether technological investments generate sustainable organizational value.

The exploratory inferential analysis reinforces the qualitative findings. Organizational readiness demonstrated a positive relationship with perceived technology-supported mobility effectiveness, while personnel competence also contributed significantly to the observed variation. The findings should be interpreted cautiously because the analysis represents an exploratory case study and does not establish causal relationships. The statistical evidence nevertheless strengthens the argument that technological capability and organizational capacity must develop simultaneously to produce meaningful improvements in mobility-related organizational functions.

The case study provides a contextual interpretation of these findings within the Indonesia–Papua New Guinea border environment. Geographic remoteness, difficult terrain, and limited infrastructure create substantial information-management challenges for organizations operating across dispersed areas. Drone and satellite technologies can supplement existing information resources by improving access to spatial and environmental information. The principal finding is therefore that technological integration is most effective when treated as a sociotechnical organizational process involving technology, personnel, procedures, infrastructure, and institutional coordination.

The findings are consistent with previous research demonstrating the usefulness of satellite remote sensing and unmanned aerial technologies for geographic observation, environmental assessment, disaster management, and infrastructure monitoring. Existing studies generally emphasize the ability of these technologies to provide timely spatial information across areas that are difficult to access through conventional methods. The present study supports this technological perspective while extending it into the organizational domain. The central issue is not simply whether the technologies can generate information, but whether organizations possess the capacity to transform that information into useful institutional knowledge.

Previous studies of drone applications frequently emphasize technical characteristics such as spatial resolution, flexibility, coverage, and data acquisition efficiency. Such research is valuable for evaluating technological performance but may provide limited explanation of organizational factors influencing adoption. The present findings indicate that technical capability alone cannot explain organizational effectiveness. Training, data interpretation, institutional procedures, infrastructure, and coordination mechanisms substantially influence the usefulness of digital technologies. The study therefore adds an organizational dimension to technology-centered discussions.

Research concerning satellite technologies has similarly demonstrated their importance for broad-scale environmental and geographical assessment. Satellite-based information can provide extensive spatial coverage and support monitoring across remote areas. The present study agrees with this evidence but identifies a complementary relationship between broad-scale satellite information and more localized drone-derived information. The significance of this relationship lies not in operational deployment patterns but in the organizational principle that different information sources can be integrated to strengthen institutional understanding of complex environments.

Research on military and border organizations has traditionally emphasized logistics, personnel readiness, infrastructure, institutional coordination, and organizational resilience. The

present study connects these organizational concerns with digital transformation while maintaining an intentionally non-operational perspective. The findings suggest that emerging technologies should be incorporated into existing organizational systems rather than considered independent solutions. This distinction contributes to the literature by demonstrating that digital transformation in border organizations is fundamentally an institutional process involving people, procedures, technology, and governance.

The findings signify a broader transformation in organizational mobility from a primarily physical concept toward one that also incorporates information accessibility and digital connectivity. Mobility is conventionally associated with the ability to move personnel and resources across geographical spaces. The results suggest that effective organizational mobility also depends on the ability to obtain, interpret, and distribute relevant information efficiently. Digital technologies therefore expand the meaning of mobility by strengthening the informational conditions under which organizations coordinate their activities.

The findings also signify that technological sophistication does not automatically produce organizational effectiveness. The positive relationship between organizational readiness and perceived technological usefulness demonstrates that digital transformation requires complementary institutional capabilities. An organization may possess advanced equipment but obtain limited benefits if personnel lack appropriate competencies or if information cannot be integrated into established procedures. Technology should therefore be understood as an enabling capability whose organizational value depends on the surrounding institutional system.

The study further signifies the importance of human agency in technology-supported organizational transformation. Personnel remain central to interpreting information, evaluating its relevance, coordinating institutional responses, and maintaining technological systems. The results challenge technologically deterministic assumptions that digital tools independently improve organizational performance. Human competencies, organizational learning, and institutional adaptation remain essential components of successful digital transformation.

The findings signify a potential shift toward more adaptive forms of border management in geographically complex environments. Such adaptation should not be understood exclusively through technological expansion but through the development of organizational systems capable of using information responsibly and effectively. The integration of geospatial technologies can strengthen institutional awareness while preserving the importance of established organizational structures. The broader lesson is that digital transformation becomes meaningful when technological capabilities are embedded within appropriate governance and human-resource systems.

The primary practical implication is that institutions considering drone and satellite technologies should adopt an integrated organizational strategy rather than focusing exclusively on equipment procurement. Investment in personnel training, data-management capacity, infrastructure, maintenance, and institutional procedures should accompany technological acquisition. The findings indicate that organizational readiness is a critical condition for realizing the benefits of digital geospatial technologies. Technology planning should therefore be incorporated into broader institutional development strategies.

The findings also have implications for human-resource development. Personnel require competencies not only in operating technological systems but also in interpreting spatial information, evaluating data quality, managing digital information, and understanding institutional procedures governing its use. Continuous professional development can help organizations maintain technological effectiveness as systems and analytical capabilities evolve. Human-resource policies

should therefore treat digital literacy and geospatial competence as components of organizational readiness.

The research has implications for institutional governance and data management. Digital technologies generate information that must be managed according to clear principles concerning access, accuracy, security, storage, responsibility, and appropriate use. Institutional procedures should establish clear boundaries concerning data management while ensuring that relevant information can support legitimate organizational decision-making. Such governance is particularly important in sensitive border contexts where technological information may have implications beyond ordinary administrative activities.

The broader implication concerns the development of resilient and adaptive border institutions. Remote geographical environments require organizations to manage uncertainty, infrastructure limitations, and changing environmental conditions. Digital geospatial technologies can contribute to this capacity when integrated with sound organizational practices. The findings suggest that future technology policies should evaluate success through organizational outcomes such as information accessibility, coordination quality, institutional responsiveness, and resource efficiency rather than through technological acquisition alone.

The positive contribution of satellite technologies can be explained by their capacity to provide broad spatial information across geographically dispersed areas. Remote border environments can present significant challenges for conventional information collection because terrain, infrastructure, and distance affect accessibility. Satellite-based information can supplement existing institutional knowledge by providing consistent spatial perspectives. The organizational benefit consequently arises from improved informational awareness rather than from technology functioning independently of human decision-making.

The usefulness of drone technology can be explained by its capacity to provide complementary localized information under appropriate institutional and regulatory conditions. Localized observations may help organizations understand specific environmental or infrastructure conditions that broader datasets cannot fully represent. The value of such information depends on appropriate interpretation and integration into organizational systems. The finding therefore reflects a complementarity between technological capabilities and institutional processes.

The strong relationship between organizational readiness and perceived technology usefulness can be explained through the sociotechnical nature of digital transformation. Technologies require skilled users, reliable infrastructure, appropriate procedures, and organizational support before they can generate meaningful outcomes. Personnel competence determines the ability to interpret information, while institutional procedures determine how information is incorporated into organizational processes. The findings are therefore consistent with the principle that technological effectiveness is partly a function of organizational capacity.

The observed differences among organizational functions can be explained by variations in technological exposure and professional responsibilities. Personnel working directly with information management and technology support naturally encounter digital systems more frequently than personnel whose responsibilities are primarily administrative or logistical. Different levels of familiarity can influence perceptions of technological usefulness and confidence in using digital information. The findings emphasize the importance of cross-functional training and organizational learning when implementing new technologies.

Future research should examine the long-term organizational effects of integrating drone and satellite technologies into border-management institutions using longitudinal designs. Such research could assess whether improvements in information accessibility and organizational coordination

remain sustainable over time. Longitudinal evidence would also help distinguish temporary perceptions of technological usefulness from durable organizational transformation. Future studies should maintain appropriate boundaries concerning sensitive operational information.

Further research should develop comparative studies involving different geographical and institutional contexts. Comparisons among remote border regions could identify which organizational factors are consistently associated with successful technology adoption and which factors are context-specific. Comparative research could also examine differences in infrastructure readiness, personnel competencies, institutional governance, and technological sustainability. Such evidence would strengthen the generalizability of findings beyond a single case.

Future investigations should also explore the integration of advanced analytical technologies, including artificial intelligence and geospatial analytics, from an organizational rather than purely technical perspective. Research should examine how automated analytical systems influence human decision-making, institutional accountability, data governance, and professional competencies. Particular attention should be given to transparency, reliability, privacy, cybersecurity, and appropriate human oversight when increasingly sophisticated digital systems are introduced into sensitive institutional environments.

The next stage of research should move toward developing an organizational maturity framework for responsible geospatial technology adoption. Such a framework could assess technological readiness alongside human resources, infrastructure, data governance, institutional procedures, interoperability, and sustainability (Lewerissa dkk., 2025). The objective would be to provide organizations with a structured basis for evaluating whether they are prepared to adopt and maintain digital technologies effectively. The findings of this study provide an initial foundation for such a framework by demonstrating that successful technology utilization depends not on technological sophistication alone, but on the capacity of institutions to integrate technology responsibly into their broader organizational systems.

CONCLUSION

The most important finding of this study is that drone and satellite technologies can support organizational mobility in geographically challenging border environments primarily by improving access to spatial and environmental information, rather than by replacing conventional personnel or institutional mechanisms. The distinctive finding is that technological usefulness depends strongly on organizational readiness, personnel competence, data-management capacity, infrastructure, and institutional procedures. Satellite technologies provide broad spatial context, while drones can offer complementary localized information under appropriate authorization and governance. The results indicate that digital geospatial technologies become organizationally valuable when their outputs are integrated into established information and coordination processes. This finding challenges technology-centered assumptions by demonstrating that the effectiveness of digital tools is fundamentally shaped by the organizational environment in which they are implemented.

The principal contribution of this research is methodological and conceptual because it proposes a sociotechnical framework for examining technology-supported organizational mobility in remote border-management contexts. The framework connects technological capability with organizational readiness, human competence, information integration, infrastructure, and institutional governance. This approach extends conventional studies that evaluate drones and satellites primarily according to technical performance by examining how technological information is transformed into organizational value. The research contributes a contextualized perspective for understanding digital transformation within complex institutional environments and provides a basis for evaluating technology adoption beyond equipment availability, emphasizing sustainable organizational capacity and responsible technology integration.

The study has several limitations that should guide future research. The case study involved a relatively limited purposive sample and focused on non-sensitive organizational information, which restricts the generalizability of the findings and prevents detailed assessment of operational outcomes. The exploratory statistical analysis also identifies associations rather than causal effects, while perceptions of technological usefulness may differ from objectively measured organizational performance. Future research should employ longitudinal and comparative designs across different border environments, incorporate larger samples, and develop validated measures of organizational mobility and technology maturity. Further studies could investigate the integration of advanced geospatial analytics and artificial intelligence while examining data governance, cybersecurity, privacy, human oversight, interoperability, and institutional sustainability.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used Grammarly to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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