


## Analysis of DPT and Polio Immunization Management in Infants in the Health Center Areas of South Central Timor Regency

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Article Info	ABSTRACT
<p><b>Keywords:</b> Immunization, Health management, Cold chain, Human resources, Digital reporting;</p>	<p>The basic immunization program is a strategic effort to reduce morbidity and mortality in infants from preventable diseases. This study aimed to analyze the management of the DPT and Polio immunization program for infants in the working areas of Health Centers in South Central Timor Regency, covering aspects of planning, implementation, human resources, and digital reporting systems. The study used a qualitative approach with purposive sampling at four health centers, namely Kota, Taneotop, Lotas, and Siso. Data were collected through in-depth interviews, observation, and document review, then analyzed using the Miles and Huberman model, which includes data reduction, presentation, and conclusion drawing. The results showed that most health centers had conducted vaccine and logistics planning according to standards, but were not yet fully capable of independently managing the cold chain. Immunization was carried out routinely and through mass campaigns, although challenges remained related to electricity, vaccine distribution, and limited storage facilities. In terms of human resources, only some staff had received technical training, while others had not fully developed competencies in logistics management and digital reporting. The implementation of the ASIK and SMILE applications improved the accuracy and efficiency of reporting but was not yet uniformly applied across all areas due to infrastructure and network limitations. In conclusion, the success of the immunization program in South Central Timor Regency heavily relies on data-driven planning, capacity building for staff, and the strengthening of an integrated and sustainable digital system.</p>
<p>This is an open access article under the <a href="https://creativecommons.org/licenses/by-nc/4.0/">CC BY-NC</a> license</p> 	<p><b>Corresponding Author:</b> Junia Jessy Sarupy Nusa Cendana University Kupang <a href="mailto:sarupyjunia@gmail.com">sarupyjunia@gmail.com</a></p>

### INTRODUCTION

Immunization is one of the proven public health interventions to reduce morbidity and mortality among infants from preventable diseases. A complete basic immunization program, including antigens such as BCG, DPT-HB-HiB, Polio, and Measles/Rubella, forms part of the national strategy to achieve universal coverage. Research indicates that

immunization programs play a crucial role in achieving global health development targets (Hikmarida, 2023).

However, implementation in the field often faces managerial and technical challenges that can affect its effectiveness. In several regions of Indonesia, including areas with challenging geographical characteristics, basic immunization coverage has begun to decline or stagnate. For example, national surveys reveal that immunization coverage for DPT, Polio, and other antigens does not always meet standard targets (Afiat et al., 2021). This decline or uneven coverage indicates underlying issues, particularly regarding the sustainability and quality of immunization program management (Azizatunnisa et al., 2021). Therefore, analysis of program management at the primary health service level is essential.

Immunization program management involves several key functions, including target planning, vaccine procurement and distribution, cold chain management, recording and reporting, and monitoring and evaluation (Rahmat, 2023). If any of these management elements are not optimally implemented, immunization services and target coverage will be affected. For instance, poor cold chain management can reduce vaccine effectiveness and lower public trust in immunization programs (Syakur et al., 2021). Consequently, managerial understanding and capacity at primary health facilities are critical factors.

Common challenges in immunization management include limited vaccine storage infrastructure, dependency on electricity supply, high mobility of target infants, and inaccurate target planning due to insufficient data (Hasanuddin et al., 2022). Studies in several health centers indicate inadequate vaccine logistics facilities and inconsistent temperature monitoring (Fardila & Wibowo, 2018). These conditions highlight the importance of strengthening a management system adaptive to local conditions.

Implementation at the health center level involves not only the technical administration of vaccines but also cross-sector coordination, including community health volunteers (kaders), village governments, and public participation. Activities such as routine immunization schedules, outreach to incomplete targets, and timely reporting are part of the process. However, research shows that factors such as insufficient vaccine availability, inadequately trained health workers, and manual reporting systems remain significant constraints (Murti, 2021). Moreover, the use of digital reporting and monitoring systems is still uneven, especially in remote areas.

The decline or uneven coverage in some regions underscores the need for a comprehensive analysis of immunization program management at the primary service level. This study is essential to evaluate the extent to which planning, implementation, monitoring, and evaluation have been conducted according to standards and to identify the factors causing implementation challenges. The results are expected to provide a basis for managerial strategies to improve immunization program performance more effectively and evenly.

The focus of this study is to explore management aspects that hinder immunization coverage for infants in health center service areas. Geographical and social conditions in South Central Timor Regency also serve as external factors affecting immunization

achievements. Most areas remain rural, with limited access to health services, vaccine distribution, and adequate cold storage facilities. (Luh et al., 2022) note that areas with difficult transportation often experience vaccine distribution delays and irregular service schedules. These conditions pose challenges for immunization officers to ensure each infant receives the complete dose according to the established schedule. In addition, fluctuating electricity availability in some health centers leads to suboptimal cold chain management.

Regarding human resources, the immunization program requires personnel competent and trained in vaccine logistics management and risk communication to the public. However, some studies have found that many staff at primary service facilities have not received adequate technical immunization training (Reviana, 2018; Widyastuti et al., 2023). This competency gap affects record-keeping, vaccine handling, and data analysis of immunization coverage. Strengthening the capacity of immunization personnel is essential to ensure the program runs according to the Ministry of Health's standard operating procedures.

Beyond technical and human resource aspects, immunization success is also strongly influenced by community acceptance of vaccines. Misperceptions about side effects, lack of information, and reluctance to attend immunization schedules contribute to declining coverage (Rahman, 2024). Effective communication and community-based approaches must continue to build public trust, while involvement of community health volunteers and local leaders strengthens social networks supporting immunization participation at the village level.

Monitoring and evaluation play a critical role in ensuring program sustainability. Effective evaluation helps identify technical barriers, staff performance, and logistic availability, forming the basis for policy improvements (Fitriana et al., 2022). Digital monitoring systems such as ASIK (Aplikasi Sehat Indonesiaku) and SMILE (Electronic Immunization and Logistics Management System) are being implemented to accelerate real-time reporting (E. P. Kurniawati & Widoatmodjo, 2023). However, implementation is not yet uniform, especially in remote areas with limited internet access. Therefore, strengthening digital systems and staff capacity is necessary to manage immunization data accurately, efficiently, and sustainably.

Considering these factors, this study is important for analyzing the management of planning, implementation, monitoring, and evaluation of DPT and Polio immunization programs for infants in the working areas of health centers in South Central Timor Regency. The study is expected to provide empirical contributions to improve immunization management strategies at the health center level, strengthen coordination between officers and the Health Department, and enhance program effectiveness in achieving universal immunization coverage targets.

An essential component of immunization program success is an integrated and sustainable logistics system. Timely vaccine availability and efficient distribution are key indicators of public health management quality at the regional level. According to (Dini et al., 2021), backup systems for vaccine refrigerators should be developed, particularly in areas with unstable electricity supply, to maintain safe storage temperatures of 2–8°C. Failure to

maintain proper storage temperatures can reduce vaccine potency and increase the risk of vaccine wastage. Therefore, logistic support, temperature monitoring, and staff preparedness are vital aspects of a sustainable immunization supply chain.

Central government policy through the Ministry of Health also plays a significant role in ensuring program continuity. The implementation of the Minister of Health Regulation No. 12 of 2017 mandates that planning for syringes, safety boxes, and cold chain equipment is integral to national vaccine planning. However, in practice, some regions still face challenges in synchronizing planning between local governments and provincial Health Departments. (Karlina, 2017) found that most health centers have not systematically evaluated logistics, causing mismatches between target population and vaccine needs. This condition underscores the urgency of strengthening vertical coordination across government levels to enhance immunization program effectiveness.

Besides regulatory and technical aspects, community participation significantly influences the success of basic immunization. Public misunderstanding of vaccine benefits, fear of side effects, and exposure to invalid information often hinder immunization implementation (Manila & Sarto, 2017). Sociocultural factors also play a critical role, particularly in rural areas with strong traditional belief systems. Participatory education and communication approaches are essential to address these issues. Involvement of community leaders and local authorities has been proven to increase vaccine acceptance and reduce social resistance to immunization activities (Edayani & Suryawati, 2019.)

Digital transformation in health services offers potential improvements in immunization reporting and monitoring. Applications such as ASIK and SMILE are designed to accelerate real-time data reporting (A. Kurniawati & Yuliwati, 2023). However, implementation remains suboptimal in areas with limited internet access and low digital literacy among health workers. (Fitriana et al., 2022) emphasize that digital system use must be accompanied by regular training and technical support to avoid information gaps across regions. Strengthening digitalization systems is a strategic step toward modern and accountable immunization management.

Finally, the success of immunization programs relies on continuous monitoring and evaluation. Monitoring ensures program implementation follows plans and identifies emerging problems early. (Fitriana et al., 2022) highlight the importance of monthly evaluations through mini-workshops at health centers as forums to review program achievements and follow up on improvements. Evaluation is not merely administrative but also serves as an institutional learning tool to strengthen accountability and program innovation. Data-based and cross-sector participatory evaluation accelerates the achievement of Universal Child Immunization (UCI) targets at the regional level.

In conclusion, the main challenges in the immunization program in South Central Timor Regency are not only related to vaccine availability but also to suboptimal management in planning, implementation, and monitoring and evaluation. Technical barriers such as limitations in logistics, personnel, and infrastructure need to be addressed through staff capacity building and integration of digital systems. Therefore, this study is directed to conduct an in-depth analysis of the management of planning, implementation, monitoring,

and evaluation of DPT and Polio immunization programs for infants in health center service areas, aiming to provide relevant policy recommendations to improve immunization service performance in the future.

## METHODS

This study employed a qualitative approach aimed at providing an in-depth description of phenomena related to the management of DPT and Polio immunization programs for infants in the working areas of health centers in South Central Timor Regency. This approach was chosen because it enables a contextual understanding of immunization program implementation, including planning, execution, and monitoring and evaluation conducted by field personnel. According to (Murdiyanto, 2020), qualitative methods aim to understand the meaning behind human behavior and complex social interactions, rather than merely measuring phenomena statistically. Therefore, the findings of this study are expected to reveal the dynamics of immunization management within a region characterized by geographical challenges and limited resources.

The research was conducted in four health centers representing the operational areas of the South Central Timor Regency Health Office: Puskesmas Kota, Puskesmas Taneotop, Puskesmas Lotas, and Puskesmas Siso. Locations were purposively selected considering variations in immunization coverage, geographical access, and availability of human resources. These four health centers were deemed to represent diverse conditions in terms of service management, vaccine logistics, and reporting systems. This variation-based site selection aimed to provide a comprehensive overview of immunization program implementation in both rural and semi-urban areas of South Central Timor Regency.

The study utilized both primary and secondary data. Primary data were collected through in-depth interviews with various informants, while secondary data were obtained from official documents such as health center profiles, immunization coverage reports, and data from the South Central Timor Regency Health Office for 2021–2022. The use of both data types aimed to enhance the validity of results through triangulation. Primary data provided empirical insights from field actors, while secondary data strengthened understanding of policies and administrative performance of the immunization program in the study area.

Informants were selected based on specific inclusion criteria using purposive sampling, targeting those considered to have relevant and in-depth information on immunization program implementation at the health centers. Informants were categorized into three groups: (1) key informants, namely the heads of each health center; (2) primary informants, including immunization managers and implementers at the health centers; and (3) supplementary informants, such as immunization cadres involved in Posyandu activities. Informant selection was based on direct involvement in planning, vaccine distribution, immunization delivery, and reporting. The number of informants was determined according to the principle of data saturation, with data collection ceasing when information became repetitive and no new findings emerged.

The main data collection technique was in-depth interviews guided by a semi-structured framework, allowing researchers to explore informants' experiences, perspectives, and challenges openly. Interviews were conducted directly at each health center between September and October 2023. In addition to interviews, field observations were conducted on vaccine storage facilities (cold chain), reporting systems, and immunization services at Posyandu. Researchers also collected administrative documents, such as local monitoring reports (PWS) and records from ASIK and SMILE applications used by personnel.

To ensure data credibility and validity, the study applied the four criteria proposed by (Lincoln & Guba, 1985): credibility, transferability, dependability, and confirmability. Credibility was established through source and method triangulation, comparing interview results among informants with documentary data from the Health Office. Transferability was achieved by providing detailed descriptions of the research context, allowing the findings to serve as a reference for other areas with similar characteristics. Dependability and confirmability were reinforced through audit trails and systematic field notes to ensure consistency in the analysis process.

Data analysis followed an interactive process based on the (Miles et al., 2014)consisting of three main stages: data reduction, data display, and conclusion drawing/verification. Data reduction involved identifying key information from interviews and documents, which were then categorized according to the study's main themes: planning, implementation, and monitoring and evaluation. Reduced data were presented descriptively to facilitate the identification of patterns and relationships among variables. Conclusions were drawn progressively from the initial data collection stage through the final analysis to ensure interpretations were valid and contextually grounded.

Ethical considerations were also a priority. The study underwent an ethical review and was approved by the Health Research Ethics Committee of Universitas Nusa Cendana (Certificate No. 107/UN15.16/KEPK/2020). All informants were informed about the study's objectives, benefits, and procedures prior to interviews. Participation consent was obtained verbally, with guarantees of confidentiality for both informants' identities and the data provided. The research adhered to public health research ethics principles, including respect for autonomy, justice, non-maleficence, and beneficence.

By employing a qualitative approach focused on in-depth description, this study is expected to provide empirical contributions to strengthening immunization program management at the health center level. The findings not only depict factual program implementation conditions but also identify barriers and opportunities for improvement that can inform local policymakers. This participatory and contextual approach ensures that the results are relevant for strategic decision-making in public health, particularly for enhancing basic immunization systems for infants in South Central Timor Regency.

Before presenting data in tables, it is essential to explain the research context so that readers understand the rationale for site and informant selection. South Central Timor Regency has diverse geographic characteristics, ranging from urban areas to remote rural regions with complex geographical challenges. The selection of four health centers—Kota,

Taneotop, Lotas, and Siso—was intended to represent variations in immunization coverage, resource availability, and infrastructure. This approach allowed the researchers to obtain a comprehensive view of immunization program implementation across different local conditions and to identify specific factors affecting infant immunization coverage in each area.

Additionally, the four sites were selected because they exhibit different program implementation dynamics in terms of target achievement, logistic availability, and coordination with the Regency Health Office. For example, Puskesmas Kota is located in an area with easy transportation access and adequate cold chain facilities, whereas Puskesmas Siso faces electricity limitations and distance challenges from vaccine distribution centers. To clarify these empirical conditions, the following table presents the characteristics of the research sites and the classification of involved informants, enabling readers to understand the operational context of DPT and Polio immunization program implementation in the field.

**Table 1.** Details of Research Locations and Characteristics of Community Health Centers

No	Name of Community Health Center	Location (District/Village)	DPT Immunization Coverage 2022 (%)	Polio Coverage 2022 (%)	Number of Immunization Officers	Accessibility
1	Kota Community Health Center	Soe	89.2	87.5	4	Easy
2	Taneotop Community Health Center	Amanuban Timur	82.3	83.7	3	Moderate
3	Lotas Community Health Center	Kie	78.4	79.1	3	Difficult
4	Siso Community Health Center	Polen	75.6	76.2	2	Difficult

Description: Secondary data from the South Central Timor District Health Office (2022).

**Table 2.** Classification of Research Informants

Informant Categories	Number (of people)	Position/Function	Reasons for Selection
Key Informants	4	Head of Community Health Center	Knowledge of immunization policies and program implementation
Primary Informants	8	Immunization manager and administrator	Direct responsibility for planning, implementation, and reporting activities
Additional Informants	4	Posyandu cadre	Supporting

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immunization  
 implementation and  
 field sweeping  
 activities

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Note: Data obtained from interviews and field observations (September–October 2023).

**Table 3.** Data Analysis Procedure Model by Miles & Huberman (2014)

Analysis Stage	Process Description	Expected Results
Data Reduction	Filter interview results and documents according to the research focus (planning, implementation, monitoring, evaluation)	Formulation of key themes
Data Presentation	Compile findings into a narrative matrix and direct quotes from informants	Contextual overview of program implementation
Conclusion Drawing	Interpret the relationship between themes and confirm key findings	Policy and field practice recommendations

The presentation of the tables above clarifies the research structure and strengthens methodological validity by systematically outlining the main components of the study. Table 1 illustrates the diversity of geographical conditions and immunization coverage across the selected health centers, providing the basis for comparative analysis in this study. Table 2 displays the categorization of informants by their roles and functions, demonstrating a balance among managerial, technical, and participatory perspectives in data collection. This allows readers to assess that the study has considered the diversity of information sources and representative field conditions.

Furthermore, Table 3 presents the data analysis procedures based on the Miles and Huberman (2014) model, which serves as the main analytical framework for this qualitative study. Through the stages of data reduction, data display, and conclusion drawing, information collected from interviews and observations is systematically processed to produce credible findings. The inclusion of these tables enhances the methodological structure by presenting the research workflow transparently and logically, ensuring that the study results are scientifically accountable and can be readily replicated by other researchers in the field of public health.

## RESULTS AND DISCUSSION

### Results

The results of this study indicate that the planning of the DPT and Polio immunization program in South Central Timor Regency has been conducted by all health centers through annual activities, which include target population calculation, vaccine requirements, syringes, and safety boxes. However, cold chain planning has not been fully implemented as it is entirely determined by the Health Office. Target projections are based on population calculations for each village or sub-district, but high population mobility makes it difficult to

determine the exact number of target infants. This affects the accuracy of immunization logistics planning at each health center, particularly at Puskesmas Taneotop and Siso, which face limited field data and have not fully optimized newborn target validation.

The implementation of immunization at all health centers generally follows national standard guidelines. Service preparation includes target inventory, vaccine and cold chain readiness, and cross-sector coordination with village governments, cadres, and healthcare personnel. Each health center has a routine immunization schedule, and any schedule changes are coordinated with village health staff. Education and counseling for mothers of infants are provided prior to immunization as a form of education and informed consent. Sweeping activities are also routinely conducted to reach infants who have not yet received complete immunization. Nevertheless, some health centers face vaccine shortages due to delayed distribution from the Health Office and electricity disruptions affecting vaccine storage.

Vaccine chain management at each health center follows standard procedures, maintaining storage temperatures of 2–8°C in vaccine refrigerators monitored twice daily. Vaccines are distributed according to target numbers and transported using vaccine carriers with cool packs. However, not all Posyandu sites have thermometers to monitor temperatures during transport, potentially reducing vaccine effectiveness. At Puskesmas Taneotop, vaccines are even stored in the village office due to the lack of electricity at the health center. This highlights the importance of supporting resources such as backup generators to ensure stable storage temperatures.

Medical waste handling in all health centers is conducted according to standard operating procedures, where used syringes are immediately placed in safety boxes and later collected at the health center for destruction. Waste disposal is carried out in collaboration with licensed third parties approved by the Health Office. This process is crucial to prevent cross-contamination and maintain the safety of healthcare staff. However, at some remote Posyandu sites, transporting medical waste to the health center remains challenging due to limited access.

Immunization personnel consist of doctors, midwives, and nurses, most of whom hold a diploma-level qualification. However, not all immunization managers have received technical training on vaccine logistics management and digital applications such as ASIK and SMILE. Only some health centers reported having participated in technical guidance from the Health Office. This situation results in variations in staff understanding of reporting procedures and vaccine handling. Task distribution between logistics managers and immunization officers is not yet fully ideal, as in some centers, such as Taneotop and Siso, one person holds dual roles.

Immunization recording and reporting are conducted both manually and digitally through ASIK and SMILE applications. Data are recorded at each Posyandu and summarized at the sub-district level before being submitted to the Health Office monthly. The main obstacles in reporting include delays in data compilation from multiple health programs and limited internet connectivity. Nevertheless, most health centers have shown improvements in data accuracy and timeliness compared to the previous year. Digital system integration

has the potential to enhance recording efficiency and accuracy but still requires improvements in human resource capacity and infrastructure.

Monitoring and evaluation are conducted by health center heads, immunization managers, and the Health Office through monthly mini-workshops and field visits. Evaluations include monitoring immunization coverage, logistic availability, and field challenges faced by staff. District-level evaluation meetings are also held periodically to ensure follow-up on field monitoring results. Digital reporting mechanisms such as ASIK facilitate data-based supervision by the Health Office; however, feedback mechanisms still need to be strengthened to ensure that monitoring results are effectively used for continuous program improvement in planning and implementation.

Overall, the study findings indicate that the management of the DPT and Polio immunization program in South Central Timor Regency is generally well-executed, yet weaknesses remain in target population planning, provision of electricity for cold chain operations, and technical training for personnel. The future success of the program largely depends on cross-sector collaboration, strengthening digital data management, and local government policy support to improve immunization logistics infrastructure.

To clarify field findings, a summary table was prepared to compare the health centers across four main aspects of immunization program management: planning, implementation, monitoring, and evaluation. This table illustrates regional variations and shows the extent to which each health center meets the standards for complete basic immunization implementation. Presenting data in tabular form also highlights the relationships between resource availability, reporting systems, and immunization coverage achieved during the study period.

Additionally, the inter-center comparison provides a basis for identifying barriers and supporting factors in program implementation. Through this mapping, the researchers can assess the consistency of immunization policy implementation and the effectiveness of coordination between the Health Office and primary healthcare facilities. The results presented in the following table were obtained through in-depth interviews, field observations, and reviews of official documents from the South Central Timor Regency Health Office for 2022–2023.

**Table 4.** Summary of Research Results on DPT and Polio Immunization Program Management

Management Aspects	City Health Center	Taneotop Community Health Center	Lotas Community Health Center	Siso Community Health Center	General Information
Planning	Accurate target data, vaccine calculations according to targets	Fluctuating target data, suboptimal cold chain planning	Targets are determined by the agency, logistics planning is not yet integrated	Difficulty determining targets due to high mobility	Inter-sectoral planning coordination still needs to be strengthened.

Management Aspects	City Health Center	Taneotop Community Health Center	Lotas Community Health Center	Siso Community Health Center	General Information
Implementation	Regular immunization schedule, sufficient personnel, ASIK & SMILE active	Vaccine shortages and power outages	Active sweeping activities, but limited cadres	Cold chain disrupted due to lack of permanent electricity	Implementation is going well but is not yet uniform.
Monitoring	Monthly evaluation by the head of the health center	Regular supervision by the agency, no written feedback	Monthly internal mini workshops	Limited monitoring due to weak network	A digital data-based feedback system is needed.
Evaluation	Regular reports, submitted on time	Delays in reporting due to manual recapitulation	Evaluation accompanied by follow-up improvements	Evaluation only verbal	Digitizing reports can improve accuracy and efficiency.
Human Resources	Trained personnel, have participated in immunization training	Not all officers are trained	Last training in 2020	No advanced training	Human resource capacity needs to be updated regularly.
Facilities and Logistics	Cold chain functioning well, generator available	Unstable cooling facilities	Complete equipment but limited safety boxes	No vaccine refrigerator	Logistics infrastructure still varies.
Reporting	Digital through ASIK and SMILE	Combination of manual and digital	Still predominantly manual	Manual due to lack of internet	Digital reporting systems are still uneven.

The table demonstrates significant variations among health centers in terms of facility availability, human resource capacity, and the effectiveness of reporting systems. Puskesmas Kota showed the best performance in both implementation and reporting, supported by well-trained staff and adequate logistic infrastructure. In contrast, Puskesmas Siso faced the greatest challenges due to limited electricity and internet connectivity, resulting in reporting processes still being conducted manually. Geographic and resource factors proved to be the main determinants of successful immunization implementation.

This comparative result underscores that although immunization policies are implemented nationally, their effectiveness heavily depends on the readiness of management at the primary healthcare facility level. Strategies to strengthen management at the regional level are needed, including enhancing human resource capacity, providing sustainable cold chain logistics, and integrating digital reporting systems. These findings provide a foundation for local government to improve monitoring and evaluation systems, ensuring that the immunization program is implemented more effectively and sustainably across South Central Timor Regency.

## Discussion

### 1. Immunization Program Planning

Immunization program planning is the fundamental basis that determines the success of immunization activities at the health center level. Based on the study results, all health centers conducted planning for vaccine needs, syringes, and safety boxes; however, cold chain planning was not fully optimized as it was still determined by the Health Office. This condition indicates that planning is not entirely based on local needs analysis but remains top-down. According to (Rahmat, 2023), the effectiveness of immunization management largely depends on the extent to which service units can adapt planning to field conditions, including geographic context and available facilities. Therefore, health centers need greater autonomy to independently estimate logistics requirements according to local potential.

The main challenge in the planning stage is the inaccuracy of target data due to population mobility and limited recording systems. Many health centers still rely on projections from the Health Office without adequate field verification. Consequently, discrepancies between the number of targeted infants and actual immunization coverage frequently occur. According to (Widyastuti et al., 2023), weaknesses in target data validation can lead to logistics waste or vaccine shortages in the field. Hence, regular data quality audits (DQA) are crucial to ensure alignment between projected and actual data at the posyandu level. DQA implementation can also serve as a performance indicator for immunization managers at health centers.

Moreover, cross-sector participation is an important factor in strengthening the planning stage. The study indicated that health centers involving posyandu cadres, village authorities, and sub-district staff in planning vaccine needs tend to have more accurate target data. Fitriana, Yarmaliza, and Tengku (2022) assert that intersectoral collaboration facilitates information exchange regarding newborns and population mobility, improving the accuracy of immunization planning. This approach aligns with the bottom-up planning principle in primary health systems, emphasizing community participation in every public program planning process.

In addition to data validation, immunization scheduling is also critical in planning. Some health centers in the study area still set a fixed service date, resulting in many target individuals being unable to attend due to time and transportation limitations. Hasanuddin, Nurhayati, and Rachman (2022) highlight that immunization schedules should be adjusted according to the community's socioeconomic conditions to increase participation. Implementing flexible or mobile immunization schedules can be an effective strategy for

areas with widely dispersed populations and limited access, such as South Central Timor Regency.

Lastly, planning logistics needs requires proper coordination with the Health Office to prevent vaccine distribution delays. One strategy is the use of integrated digital systems such as SMILE (System for Immunization Logistics Management Electronic), which allows real-time stock-based planning. (A. Kurniawati & Yuliwati, 2023) explain that SMILE effectively accelerates vaccine planning and distribution at primary healthcare facilities. Therefore, effective immunization program planning should combine a participatory, data-driven approach supported by modern logistics information systems to ensure sustainable vaccine availability.

## **2. Service Implementation and Vaccine Distribution**

The implementation of the immunization program in South Central Timor Regency has generally followed the Ministry of Health technical guidelines; however, field implementation still faces challenges. The study found that all health centers conducted routine immunization and sweeping activities for children with incomplete immunizations, coordinated with village authorities, posyandu cadres, and healthcare personnel. Nonetheless, transportation limitations, power outages, and vaccine distribution delays from the health office were the main obstacles faced by field staff. This finding aligns with (Dini et al., 2021), who noted that remote areas with limited infrastructure tend to experience delays in vaccine distribution and storage temperature disruptions. Thus, immunization implementation depends not only on staff readiness but also on logistical stability and infrastructure support.

During immunization activities, personnel strive to maintain the cold chain to ensure storage temperatures remain within the safe range of 2–8°C. Observations showed temperature monitoring was conducted twice daily, and vaccines were transported using vaccine carriers with ice packs. However, in several health centers such as Siso and Taneotop, electricity limitations required storage in alternative facilities, such as village offices, increasing the risk of reduced vaccine efficacy if temperatures were unstable. (Syakur et al., 2021) emphasize that immunization in areas with limited electricity requires backup energy systems, such as solar power or generators, to ensure service continuity. Therefore, regional government intervention in providing these support resources is necessary.

Community education and counseling are also integral to immunization implementation. Health workers provide explanations about vaccine benefits and preventable disease risks before administration. This educational approach has been shown to increase community acceptance of immunization. (Edayani & Suryawati, 2019) stress that consistent education reduces community resistance to vaccines, especially in areas with low health literacy. In this study, posyandu-based counseling improved mothers' participation, but risk communication still needs to be strengthened to reach groups with limited understanding of complete basic immunization.

Immunization recording and reporting utilize both manual and digital methods through ASIK and SMILE applications. Health centers with stable internet can use digital applications

for daily and monthly reporting, whereas remote centers still rely on manual recording, causing differences in reporting timeliness between regions. Kurniawati and Yuliwati (2023) state that digital reporting can increase efficiency and reduce recording errors if accompanied by staff training. Therefore, effective immunization implementation requires both logistical preparedness and administrative capability in managing technology-based data.

The availability of competent healthcare personnel also influences implementation quality. Some staff have not received technical training in vaccine logistics management or digital reporting. (Reviana, 2018) explains that technical competency limitations can reduce the quality of immunization programs, particularly in vaccine quality monitoring and record-keeping. Thus, capacity-building activities through technical training and regular field supervision should be prioritized. Capacity enhancement must integrate digital monitoring systems to help staff promptly and accurately detect technical issues.

### **3. Human Resources and Staff Capacity**

The success of the immunization program heavily depends on the capacity and competency of human resources at health centers. The study found that most immunization personnel comprised experienced doctors, midwives, and nurses. However, not all staff had received technical training related to vaccine logistics management, digital application use, and system-based reporting, leading to knowledge and skill gaps. In line with Reviana (2018), unequal distribution of healthcare personnel and limited ongoing training can directly impact program quality at primary care facilities. Therefore, improving human resource capacity through regular education and training is urgently needed to ensure service quality.

In addition to technical skills, managerial competence is critical for immunization managers. Vaccine stock management, planning, and distribution scheduling require strong administrative capabilities. However, some staff face challenges in applying program management principles due to high workload and dual roles, such as managing logistics and performing field duties. Widyastuti et al. (2023) suggest that efficient workforce management can significantly enhance immunization program performance. Thus, health centers should implement proportional work distribution, clarify job descriptions, and strengthen internal supervision to prevent program disruption due to limited human resources.

Capacity strengthening activities, such as refresher training and field supervision, should be conducted regularly by the Health Office. Training should cover not only technical aspects of vaccine storage and administration but also risk management, digital reporting, and community risk communication. (Murti, 2021) found that health centers conducting at least biannual training exhibited higher reporting accuracy compared to centers without routine training. Hence, developing immunization staff capacity must be an integral part of strategies to improve primary healthcare service quality in remote areas.

Moreover, reward systems and motivational support are essential for enhancing staff performance. High performance in maintaining immunization coverage and timely reporting should be recognized through performance awards or further competency development.

(Husaini & Darmawan, 2022) emphasize that healthcare worker motivation increases when supported by recognition and positive feedback from supervisors. In this study, health center heads play a strategic role in fostering a supportive work environment and providing recognition to outstanding immunization staff.

Ultimately, improving human resource capacity in immunization programs requires not only technical training but also strengthening leadership, coordination, and institutional support. (Hikmarida, 2023) highlights that inter-staff and cross-sectoral networking accelerates decision-making and problem-solving in the field. Therefore, immunization HR development strategies should adopt a holistic approach, encompassing technical, managerial, and motivational skill enhancement to address logistical and geographic challenges in South Central Timor Regency.

#### **4. Reporting Systems and Digital Application Utilization**

Accurate and timely reporting is a key element in immunization program management, as reporting data is used for logistics planning and supervision. The study found that some health centers in South Central Timor Regency still relied on manual reporting, while others had started using ASIK and/or SMILE. Digital systems like ASIK allow real-time immunization recording and faster access to data for policymakers. National studies show that 93.5% of health centers have used ASIK for routine campaign reporting. However, differences in infrastructure readiness and staff capability create gaps in reporting effectiveness across regions.

The main challenges in implementing digital reporting applications were identified as unstable internet networks and limited devices. Staff in such facilities often rely on manual or dual-entry reporting, increasing workload and potential errors. For example, SMILE, designed for real-time vaccine logistics monitoring, faces access challenges in remote areas, limiting its optimal functionality across all health centers. This situation shows that despite technology availability, utilization remains suboptimal, leaving gaps in reporting and data-driven decision-making.

The benefits of digital reporting include faster data access and real-time monitoring, enabling quicker responses to issues in immunization implementation. UNDP-Indonesia reports that SMILE reduced vaccine stockouts (~70%) and prevented wastage due to improper storage temperatures. Similarly, UNICEF describes ASIK as a “digital lifeline” transforming child data management in Indonesia and supporting higher immunization coverage. Therefore, enhancing digital reporting is not only about administrative efficiency but also overall immunization service quality.

To maximize digital system utilization, it is necessary to strengthen staff capacity, infrastructure, and system integration. Training on ASIK/SMILE usage, improving internet access in remote health centers, and integrating applications with logistics and manual reporting systems are strategic measures. Cross-sectional studies indicate that although 80% of users understand EIR systems like ASIK, only 60% find the user interface suitable, and 59% experience system disruptions. Hence, technology will not be effective without appropriate human support and processes.

Finally, to ensure digital reporting systems function as effective managerial tools, routine evaluation and feedback should be used for improvement. Monitoring ASIK and SMILE usage should involve indicators such as reporting speed, data accuracy, and program follow-up based on collected data. The study findings show that although digital adoption exists, feedback and active data utilization are not yet uniform. Therefore, local policies must ensure that digital reporting systems are not merely installed but integrated into routine workflows, supported by training, supervision, and adequate infrastructure.

## CONCLUSION

The management of the DPT and Polio immunization program in South Central Timor Regency has been functioning reasonably well, yet several challenges remain. Health centers have planned for vaccine, syringe, and safety box needs, but they lack full authority over cold chain management, which is still determined by the Health Office. High population mobility also affects the accuracy of target data, limiting the effectiveness of local needs-based planning. Implementation shows strong commitment from health personnel and community cadres, but delays in vaccine distribution, power outages, and limited storage facilities continue to be major obstacles. Human resource capacity is a critical factor, as some staff have not received technical training and often perform dual roles in logistics management and reporting. Continuous capacity building through refresher training, field supervision, and motivational support is essential to ensure program quality. The use of digital systems such as ASIK and SMILE has improved reporting efficiency and data transparency, although their effectiveness is limited in areas with poor internet connectivity. For digitalization to fully support program management, staff technical skills and the integration of reporting systems with vaccine logistics must be enhanced. Overall, the study highlights that immunization program success depends not only on vaccine availability but also on managerial capacity, cross-sector coordination, and the adoption of information technology innovations that strengthen primary healthcare systems at the regional level.

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