Introduction and implementation of an immunization information system in Indonesia province of Daerah Istimewa Yogyakarta: lessons for scale-up

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Abstract

**Background**: Immunization is undeniably critical to save children from infections. To increase vaccination coverage, valid and real-time data is needed. Accordingly, it is essential to have a good report system that serves as defaulter tracking to prevent children’s immunization failure. Daerah Istimewa Yogyakarta (DIY) health office introduced an electronic immunization registry and successfully implemented it for more than five years. It is the only individual-based record system in Indonesia that has been sustainably operated for such a long time. Yet, no systematic assessment of this system had been conducted to date. This study examines Sistem Informasi Imunisasi Terpadu (SIMUNDU) introduction and implementation process in order to draw lessons that could inform scalability and sustainability across the country.

**Methods**: This study used an explanatory sequential mixed-method design, which collected quantitative data from 142 participants and qualitative data from 9 participants. Entry data clerk in health facility was systematically selected to participate in the survey. While in the key informant interview, the informant was selected based on the survey result. A descriptive and thematic approach was adopted to analyze the quantitative and qualitative data. Results from across the two approaches were integrated for comparison and contrast.

**Results**: Findings are presented according to three core themes emerged from the data: system strengths, potential threats, and opportunities for scale up. Strengths -i.e. factors contributing to the success of SIMUNDU - include management, system performance, people's behavior, and resources. Potential threats to sustaining the system include individual capacity, technical or system issues, and high workload. Opportunities – i.e promising factor that SIMUNDU can be operated sustainably – such as continuity, expectation and scale up possibility.

**Conclusions**: SIMUNDU is a promising innovation for the entire country, beyond DIY. There is agreement about the potential for scale-up of this IIS to other provinces. Experience of implementing this system in DIY over the past five years has shown that the benefits outweigh the challenges, and SIMUNDU has grown into a robust and yet user-friendly system.

**Background**: Neonatal and childhood vaccination is an essential component of infectious disease prevention and an absolute human right (1),(2). Vaccination has been proven to reduce the burden of infectious disease globally (3). According to the WHO, in 2020 estimated 23 million children under one year of age did not receive their essential vaccinations. Of these, 60% live in just ten countries, one of which is Indonesia (4). Indonesia is the fourth most populous country globally. It is composed of thousands of islands organized into 34 provinces. Various geographical and cultural factors influence population inequalities to access to health services (5). In 2001, the Indonesian government’s decentralization policy was enacted. This was an excellent strategy to foster development by engaging regional resources (6). However, this
strategy was not without consequence. One primary concern was the fragmentation of the Health Information System (HIS).

Indonesia's federal structure results in provinces and districts being relatively independent of the national Ministry of Health. This means that information systems at the provincial and district levels are locally regulated. For instance, *Pemantauan Wilayah Setempat* (PWS) is a management tool used to monitor coverage of specific health services in an administrative boundary. Depending on the service and region, it can be paper- or electronic-based. PWS-KIA is the monitoring system specific to maternal and child health (KIA), including immunization. PWS-KIA data are reported to the District or City Health Office, go to Province Health Office, and finally report to the main level. Generally, the data is in excel; it will report via emails or various information systems, including Komdat, SiTT, SIHA, PISPK, SIKDA Generik. PWS-KIA data feeds into the District Health Information System 2 (DHIS2) in some provinces. Regional information systems have varying data quality, which reflects inequities in resources across regions. This adds to data integration challenges at the national level and affects strategic policymaking.

In the context of Indonesia's federal system, Daerah Istimewa Yogyakarta (DIY) Province has the authority to regulate and use its budget within its four districts (Sleman, Gunungkidul, Bantul, Kulonprogo) and Yogyakarta city. Regarding childhood vaccination, DIY is among the top ten performing provinces in the country, with 97.7% of children completing basic immunization coverage in 2019. Immunization services are provided by Primary Health Centres or Puskesmas (PHC), as well as private clinics, hospitals, and midwives' practices (typically referred to as *Unit Pelayanan Swasta* or UPS).

In 2014, the DIY Health Office introduced an electronic immunization registry named SIMUNDU (*Sistem Informasi Imunisasi Terpadu* / Integrated Immunization Information System). An electronic immunization registry is a tool for recording individual children's immunization histories. An electronic registry serves essential functions at all levels of the health system. At the district and higher levels, it allows for monitoring vaccination coverage by the vaccine, dose, cohort, and other variables – and can support microplanning and vaccine management. The service delivery level can facilitate individual follow-up of vaccination status and enable health workers to identify children due for vaccination and those who missed their vaccinations (defaulters).

SIMUNDU was designed to link with the PWS-KIA for immunization and interoperability with the DHIS2. While it predominantly contains individual-level immunization records, SIMUNDU also serves as a source for aggregation and can synergize with the *Pemantauan Wilayah Setempat* (PWS) reporting system. For this reason, it can be considered an Immunization Information System (IIS). This means that data from City and District levels feed into Provincial and National levels.

The original prototype was designed by the information and technology (IT) department of DIY Health Office to be operated offline. In DIY, three out of the four districts and the city introduced the system in 2015. The final district introduced it in 2017. At this stage, the point of data entry was the PHC only. By 2018, UPS facilities were also equipped with SIMUNDU and could enter data into the system. In 2019, the
prototype was further developed to operate online. The online version was rolled out in 2020 (Fig. 1). As of May 2021, 79.4% of all PHC and UPS facilities were complying. This average rate masks, however, the fact that while all PHCs adopt SIMUNDU, it is more challenging to enforce its use in UPC facilities (Suyani 2020, oral communication, 2020 May 11).

When a child receives a vaccination in a health facility, information on the child and the vaccination is entered in SIMUNDU as an individual child record. Each record includes a personal identifier, the child’s socio-demographic characteristics (e.g., name, gender, date of birth, name of parents, address), the antigen administered, and the date and place of vaccination. SIMUNDU has been recently updated to allow recording of vaccinations administered in schools (e.g., Human papillomavirus (HPV), Diphtheria Toxoid (DT), Tetanus-Diphtheria (TD), and Measles-Rubella (MR), though in the form of aggregate data only. Furthermore, SIMUNDU has being developed to record COVID-19 vaccinations in health facilities and those carried out in masse.

Monitoring is conducted every month to assess data completeness across health facilities, while an evaluation is conducted every year. These exercises have allowed the identification of several challenges related to implementing the system (e.g., workload, staff turnover, and rotation) and data quality (e.g., accuracy and timeliness). However, no systematic assessment of the system has been conducted to date. SIMUNDU is the first immunization information system ever introduced in Indonesia. Other districts and provinces have shown interest in rolling it out, and the Ministry of Health has acknowledged the innovation. The objective of this work was to examine SIMUNDU's introduction and implementation process to draw lessons that could inform scalability and sustainability across the country.

Methods

From May to October 2020, we examined the experience of introducing and implementing an immunization information system in the DIY province using an explanatory sequential mixed-method design, where each step informed the next (10). First, we conducted a desk review of all relevant documentation available in the DIY health office – e.g., staff notes, meeting notes and monitoring notes – documenting SIMUNDU development and management processes. We also examined online documents, including health profiles and regulations on health reporting systems in Indonesia. This served as the initial source of data and provided an overview of who was involved and how, in developing and implementing SIMUNDU. This informed the survey design that we conducted as a second step. The survey targeted any staff responsible for entering data in SIMUNDU (i.e. data clerks) across all PHC and selected UPS facilities and any staff responsible for managing the system at the district and city level (i.e. immunization coordinators). Sampling and recruitment strategies are outlined in Table 1.
### Table 1
Survey participant

<table>
<thead>
<tr>
<th>Level of the data entry and reporting system</th>
<th>Total number of facilities/offices</th>
<th>Study population</th>
<th>Sampling strategy</th>
<th>Recruitment</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Health Centre (PHC)</td>
<td>121</td>
<td>Data entry clerks</td>
<td>All facilities</td>
<td>Open invitation across all facilities</td>
<td>113</td>
</tr>
<tr>
<td>UPS - Central, General, Maternity and Pediatric Hospitals</td>
<td>65</td>
<td>Data entry clerks</td>
<td>Randomly selected 2 facilities per district/city (2*5 = 10)</td>
<td>Open invitation across selected facilities</td>
<td>8</td>
</tr>
<tr>
<td>UPS - Clinics</td>
<td>73</td>
<td>Data entry clerks</td>
<td>Randomly selected 2 facilities per district/city (2*5 = 10)</td>
<td>Open invitation across selected facilities</td>
<td>7</td>
</tr>
<tr>
<td>UPS - Midwives’ Practices</td>
<td>271</td>
<td>Data entry clerks</td>
<td>Randomly selected 2 facilities per district/city (2*5 = 10)</td>
<td>Open invitation across selected facilities</td>
<td>10</td>
</tr>
<tr>
<td>District/City Health Office</td>
<td>5</td>
<td>Immunization coordinators</td>
<td>Total sampling</td>
<td>Open invitation</td>
<td>4*</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>142</td>
</tr>
</tbody>
</table>

*When the immunization coordinator had recently changed, the former was also invited.*

All immunization coordinators in each district/city and data entry clerks from all primary health facilities (PHC) were invited to participate in this survey. As to UPS facilities, we randomly selected two clinics, two midwives’ practices, and two hospitals per district/city, and invited all of their staff involved in SIMUNDU data entry and management.

We developed and pre-tested an online survey in Bahasa Indonesia to inquire about SIMUNDU implementation, processes, and outcomes across PHC, UPS clinics, district or city and province offices. The questionnaire consisted of close-ended and Likert scale questions – ranging from 45 to 50 depending on the target type of facility and/or level of the health system – and enquired about respondents’ socio-demographic characteristics as well as the process of implementing and managing SIMUNDU. Some questions provided an additional field for clarifying the reason for a particular choice of answer.

All participants were invited to the DIY health office to fill out the survey on their laptops, with their prior consent. Having all participants in a room allowed researchers to monitor any missing or incomplete
responses in real-time and follow-up with individual participants on-site to fill any gaps. We don't believe this may have introduced any significant bias as researchers would simply flag any missing response and invite respondents to address those. Data were then exported into and analyzed in Microsoft Excel. An exploratory analysis of the survey data informed the topic areas that qualitative interviews would delve into.

Similarly, some informants were purposefully selected among survey participants to follow up on the range of perspectives that had emerged from the survey. Other informants had been identified at the desk review stage, and chosen for their management functions. Selected informants were invited to the DIY Health Office for the purpose of the interview, and COVID-19 prevention protocol was observed. Every informant was informed about the study and asked to sign the informed consent. All invited informants agreed to participate. A total of nine 30-minute semi-structured interviews were conducted in Bahasa Indonesia language, and recorded with prior consent from participants. The interview team consisted of three researchers with the respective task of running the interview, observing and taking notes. A research assistant transcribed all interviews in Bahasa Indonesia language.

Thematic analysis was conducted using Quirkos qualitative tool following Braun and Clarke's approaches (11). Researchers familiarized themselves with the data, searching for initial codes and allowing themes to emerge. The principal investigator led the coding process, and led the research team in defining and naming the core themes emerging from the data, organizing and analyzing the data across the themes, and triangulating information from the desk review, the survey, and the interviews. This stage was also performed in Bahasa Indonesia. Data were translated to English only at sub-theme and core themes.

Results

Characteristic participant

a. Quantitative study

In total, 142 respondents participated in this study spread across five districts or cities in the DIY province. Most respondents came from Gunungkidul District, PHC, UPS, and DHO, 24.8%, 24%, and 25%, respectively. For all research units, the majority are women. At the UPS and DHO/CHO levels, most respondents aged 41–45 years, i.e., 28.3% and 75%, respectively, while at the UPS level, the majority aged 25–30 years (56.0%). For education level, PHC and UPS are dominated by Diploma 3 graduates, namely 86.7% and 80%, respectively, while in DHO/CHO, it is predominantly undergraduate graduates (75%) (Table 2)
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PHC (n = 113)</th>
<th>UPS (n = 25)</th>
<th>DHO/CHO (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>District/City</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bantul</td>
<td>23 (20.4)</td>
<td>5 (20.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Gunungkidul</td>
<td>17 (15.0)</td>
<td>4 (16.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Yogyakarta</td>
<td>21 (18.6)</td>
<td>4 (16.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Kulonprogo</td>
<td>24 (21.2)</td>
<td>6 (24.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>Sleman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3 (2.7)</td>
<td>0 (0.0)</td>
<td>2 (50.0)</td>
</tr>
<tr>
<td>Female</td>
<td>110 (97.3)</td>
<td>25 (100)</td>
<td>2 (50.0)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25</td>
<td>0 (0.0)</td>
<td>5 (20.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>25–30</td>
<td>3 (2.7)</td>
<td>14 (56.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>31–35</td>
<td>30 (26.5)</td>
<td>3 (12.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>36–40</td>
<td>19 (16.8)</td>
<td>1 (4.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>41–45</td>
<td>32 (28.3)</td>
<td>0 (0.0)</td>
<td>3 (75.0)</td>
</tr>
<tr>
<td>46–50</td>
<td>18 (15.9)</td>
<td>0 (0.0)</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>&gt; 50</td>
<td>11 (9.7)</td>
<td>2 (8.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master</td>
<td>5 (4.4)</td>
<td>1 (4.0)</td>
<td>3 (75.0)</td>
</tr>
<tr>
<td>Bachelor</td>
<td>9 (8.0)</td>
<td>2 (8.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Diploma 4</td>
<td>98 (86.7)</td>
<td>20 (80.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Diploma 3</td>
<td>1 (0.9)</td>
<td>1 (4.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Senior high school</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Qualitative study

Nine informants were recruited to provide the required information to explore deeper into the quantitative study results. They hold roles as managers and staff at DHO/CHO, PHC, and UPS. Among the nine
informants, 2 were men, and 7 were women. Three informants graduated from masters, one bachelor’s, and five diploma graduates (Table 3).

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (years)</th>
<th>Education</th>
<th>Position</th>
<th>Subject group</th>
<th>Informant's code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>56</td>
<td>Magister</td>
<td>Head of disease prevention and control department at PHO level</td>
<td>Managerial</td>
<td>M 01</td>
</tr>
<tr>
<td>Male</td>
<td>57</td>
<td>Magister</td>
<td>The former of disease prevention and control section at PHO level</td>
<td>Managerial</td>
<td>M 02</td>
</tr>
<tr>
<td>Male</td>
<td>54</td>
<td>Bachelor</td>
<td>Immunization programmer at PHO level</td>
<td>Managerial</td>
<td>M 03</td>
</tr>
<tr>
<td>Female</td>
<td>47</td>
<td>Magister</td>
<td>IT Person</td>
<td>Managerial</td>
<td>M 04</td>
</tr>
<tr>
<td>Female</td>
<td>34</td>
<td>Diploma</td>
<td>Data entry at the PHC level</td>
<td>Staff</td>
<td>S 01</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>Diploma</td>
<td>Data entry at UPS level</td>
<td>Staff</td>
<td>S 02</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>Diploma</td>
<td>Data entry at UPS level</td>
<td>Staff</td>
<td>S 03</td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
<td>Diploma</td>
<td>Data entry at the PHC level</td>
<td>Staff</td>
<td>S 04</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>Diploma</td>
<td>Data entry at the PHC level</td>
<td>Staff</td>
<td>S 05</td>
</tr>
</tbody>
</table>

c. Finding

Findings from the study are organized and presented across the three core themes that emerged from the qualitative analysis, notably system strengths, potential threats, and opportunities for scale-up. Yet, data from both the qualitative and quantitative data fed into the analysis of these core themes, to cross-validate the findings (Fig. 2. Detailed findings from the survey are presented in Table Supplement 1.

**System’s Strengths**

Factors contributing to the success of SIMUNDU include management, system performance, people’s behavior, and resources.
Management

SIMUNDU arose due to concerns from the DIY health office immunization section around data quality, notably the need to address issues related to data inaccuracy, duplicate or missing data and lack of timely data, and the need of quality data to support follow-up and appropriate planning. The need for SIMUNDU arose from these challenges and needs.

To our knowledge, [SIMUNDU development] started with a problem: estimates of the target population varied depending on the data source.

Yes, I think [SIMUNDU management team] started to tire of managing a large volume of data with dubious validity. They need to know the situation in each district.

Effective management of SIMUNDU from development to implementation was highlighted as an essential determinant of its success across the critical functions of Planning, Organizing, Leading, and Controlling.

Careful Planning was ensured at each stage of SIMUNDU development and implementation. These stages included developing an initial business plan, providing training on and socialization to SIMUNDU, and developing a staff replacement plan to respond to turnover or retirement of staff in charge of operating the system or entering data. The parties involved in planning included the head of disease prevention and control department, IT personnel, and immunization program staff from the DIY health office.

Organizing - the organization of SIMUNDU is carried out at several levels. The top level is the DIY health office, the second level is the district/city health office, and the third level is health facilities (Fig. 2). A third party was also involved in developing the system interface.

At the beginning of SIMUNDU development, essential functions included database administrators, interface designers, and server administrators, and their interplay facilitated the smooth operation of the system. Training specific to SIMUNDU was integrated with other training, typically immunization-related training. This enabled to share resources with other programs, thus ensuring viability. The training was delivered in the district/city health office: 87.6%, 72% and 75% of survey respondents from PHC, UPS and DHO/CHO respectively had participated in in-house training. Training typically consisted of short sessions and included practice on the trainee’s device on how to operate the system in both online and offline mode. Informants indicated that day-to-day operations were carried out autonomously by the staff, through flexibly adjusting their work to protect time to enter the data. And this seemed to work effectively.

Leading - the success of SIMUNDU implementation is arguably related to strong leadership. Informants noted that managers played a crucial role in bridging the needs of the immunization program with the
system design, closely monitoring the initial implementation process, and creating an enabling environment.

*I try to combine supporting and managing the people involved and monitoring them. Currently, I monitor whether [SIMUNDU] can run optimally as our users are health facilities. I also monitor program development and the system's output.*

**[SIMUNDU] was born from program managers, primary health centers, Districts, and DIY health offices wanting to build systems together. We – DIY health office - give them motivation in every meeting.**

*I see that [management] is very good at networking. Staff data entry in the field always said that these people are very kind.*

The role of IT in developing SIMUNDU was also reported to be significant. They helped develop the system and supported correct data entry by assisting data entry operators whenever these encountered technical issues or helping resolve inconsistencies in the data records. Acknowledgment of staff efforts was also an important lever to maintain motivation and buy-in.

**In the early days of SIMUNDU’s development, the system was challenging to operate, as it wasn’t as stable as it is now. I praise the enthusiasm and dedication of the users.**

The controlling function - consisting in quality assurance management - was critical to avoid data duplication or missing entries, and ultimately ensure data quality. This process was not regulated by specific Standard Operating Procedures but was addressed during training and monitored monthly. In addition, the DIY health office provided negative incentives to health facilities that were not submitting complete records and provided regular feedback from monitoring and evaluation exercises.

Specifically, 94.2%, 100%, and 100% of survey respondents in PHC, UPS, and DHO respectively, reported their work had been subject to monitoring. More than half of the respondents in PHC and UPS facilities had been observed by supervisors while performing data entry at least once over the past year. At the PHC level, 48.3% of survey respondents had been subject to monitoring from the district/city office's team, and 45.7% received monitoring from DIY health office's staff. Conversely, 40% of respondents from UPS facilities were monitored by PHC's staff. Almost all survey respondents reported receiving feedback from the monitoring, mainly from the District/City and DIY health offices. Forty percent of respondents from UPS facilities reported receiving feedback from PHC. Immunization coordinators from the District/City health offices received feedback from the DIY health office.

**In a [evaluation] meeting, DIY health office or district health office showed the progress of our data entry – correct or not, proper or not**

It is worth noting that DIY province is quite a small geographic area. Because it consists of only five districts and one city, this province is relatively easy to monitor across all phases, from planning through monitoring and evaluation.
System Performance

While SIMUNDU predominantly contains individual-level immunization records, it also serves as a source for aggregation and can synergize with other information systems. Notably, SIMUNDU can link to the DHIS2 and generate immunization-specific reports as per Ministry of Health's requirements. These reports are sent to the upper levels automatically if SIMUNDU is operated online or submitted via email if SIMUNDU is operated offline. This functionality has had an essential role in ensuring the acceptability and adoption of the system.

Informants noted how transitioning from paper-based tools to an electronic system made data entry easier and reduced errors. It also facilitated the implementation of protocols for data storage and security. It enabled follow-up and defaulter tracking. Finally, integration with the DHIS2 meant reduced workload for the staff.

*We can do faster tracking of children who may have received vaccinations in different locations. For example, when the first dose of a vaccine is given in Bantul and the second one in Yogyakarta, the record can be linked within SIMUNDU.*

*SIMUNDU makes it easier to detect what data and vaccinations are missing since we enter data from the children's birth through the end of the immunization schedule. So, we will know where they miss any vaccine.*

*The benefit of using SIMUNDU is first: we know the situation of immunizations more accurately....so our vaccine forecasting is more accurate .... and our budget, staff, facilities can be more effective and efficient in providing services.*

*Colleagues from the mother and child health (KIA) program enter the data via the KIA “Sembada.” So, this data will appear automatically in SIMUNDU because the two-system are connected.*

SIMUNDU is user-friendly and can be flexibly operated either offline or online, allowing the responsible staff to maintain data entry irrespective of connectivity. 82.3%, 96% and 100% of survey respondents from PHC, UPS and DHO respectively reported to operate SIMUNDU online.

People’s Behavior

The interview showed that staff commitment was critical for the successful implementation of SIMUNDU, as indicated by their willingness to work overtime and bring home the data to enter into the system.

*I take it [the data] home too, for example, after immunization sessions– in my clinic, immunization runs four times per month, every week. So, when the session is finished, we can take the data home, [and] do the entry at home while relaxing*
This dedication was confirmed by the interviews, which spoke to a societal culture of helping others and responsibility and commitment to the team. This contributed to shape an environment where people approach SIMUNDU as a shared responsibility and a collective endeavor. Informants also noted the high motivation of dedicated staff.

That's all; we cannot judge by money [people kindness, culture, and behavior]; it's essential to explain how good people are in Yogyakarta. I was in another place before, and I could not find people's kindness like in Yogyakarta - different characters.

The second thing is that we need human resources concerned and love for data; otherwise, even though we have a good system, it will amount to nothing without good human resources. But when people are concerned about data, good implementation will come more easily.

Resource: Material, Human And Financial

Infrastructure and equipment emerged as critical factors to introducing and sustaining SIMUNDU implementation. Some desktops were specifically allocated to the immunization program, and some had to be shared with other programs’ staff. Other data entry officers reported using their own laptop or smartphone (36.3% of survey respondents from PHC). In UPS facilities, 40.7% reported using office desktops, and in the DHO, more than half of the respondents stated they used an office-supplied laptop. The majority of respondents – regardless the type of facility - said their current device was sufficient to perform their work on SIMUNDU. Regarding connectivity, 64.6% of PHC survey respondents and 67.7% of UPS’s reported operating SIMUNDU online relying on the office’s internet connection.

Management of financial resources was also crucial. According to the key informants, no special funds were allocated to SIMUNDU in the initial stages. Resources were leveraged through sharing activities – e.g. monitoring visits or transportation - with other programs, thus allowing cost efficiencies. Integration with other programs proved critical to ensuring sustainability.

SIMUNDU’s budget comes from the state budget called as Anggaran Pendapatan dan Belanja Negara (APBN). Every year the APBN allocates a funding envelop for immunization to DIY and other provinces, where the budget is apportioned across the program [not explicitly written budget for SIMUNDU]

Human resources are critical to the operation of SIMUNDU. According to interview, SIMUNDU data entry clerks must have patience, work carefully and not rush, be interested in data, be responsible, and have basic computer skills such as Ms word and Ms excel. As shown by the survey, the large majority of SIMUNDU-operating staff was educated: at least 80% of data entry clerks in either PHC or UPS facilities have secondary education (> 80%), while at the managerial level (DHO), 75% of respondents have a bachelor’s degree (Table 2). Yet, 19.4% and 9.1% of respondents from PHC and UPS facilities, respectively have low computer literacy.
Various data entry clerks looked for strategies to resolve the obstacles they encountered when entering data to SIMUNDU. Based on the interviews, some clerks furthered their computer skills by taking private computer classes. Others learned from other colleagues at their offices, or reached out for help to the district person in charge. To deal with the accumulation of data needing to be entered in SIMUNDU, staff would sometimes work at home after office hours, as their busy schedule at work did not allow time for data entry.

*If we found obstacles, we asked people in charge in PHC – asking for a solution or sharing by WhatsApp – or sometimes I asked the IT person in the DIY health office.*

**Potential threats**

As of today, SIMUNDU can be said to be a successful experience. Yet, a number of obstacles were encountered and addressed during implementation. Potential threats to sustaining the system include individual capacity, technical or system issues, and high workload. Staff computer literacy was identified as one of the main challenges to sustainability. Internet connectivity was another obstacle, as not all health facilities were equally supported by a good network. The survey shows that 64.6% and 67.7% of PHC and UPS staff used office internet, while others had to rely on their home internet.

Further, incomplete and inconsistent records – such as differing child’s date of birth or name spelling across relevant entries - make it challenging to consistently record immunization information. These challenges have arisen during implementation, and were promptly addressed. Yet, they had an impact on staff who was already juggling busy schedule in the office, causing delays in data entry. As shown by the survey, almost all respondents stated having other responsibilities besides operating SIMUNDU – notably 97.3%, 88% and 100% of participants from PHC, UPS and district and city offices respectively.

**Opportunities**

Informants appreciated SIMUNDU as a good system for immunization data. SIMUNDU has become necessary for program managers and policymakers because it allows to monitor coverage and can inform planning and programming. Currently, SIMUNDU is stable, thus is easier to manage than when it was in the development phase. It is also viable, and no longer requires heavy reliance on the core workforce that started the system. The hopes expressed by data entry clerks in the interviews are that SIMUNDU is easier to operate, and system errors are less frequent. Informants also stressed the need for refresher training to ensure knowledge and practice of the system is not lost.

*In my opinion, SIMUNDU is the best program in DIY which is a collaboration between program managers and IT. It will continue to be implemented because it is a necessity. It has been stably used for more than five years, meaning this is needed.*

*If I have the tool, in this case, SIMUNDU, when it is stable, whoever will be able to run it, I am sure that anyone can operate it. It means that it doesn't matter if we have people shifting (jobs).*
In the future, if SIMUNDU is still used, other reports are not necessary. Now we have two different reports: SIMUNDU and stock card of vaccine – each stand-alone and need a separate report.

Based on the key informants’ interviewers, SIMUNDU is likely to be developed further or expanded to other provinces. The DIY health office is open to support other provinces interested in introducing the system, for instance through lending staff for training and orientation. However, informants advised that successful introduction requires a strong commitment from both staff and management.

Discussion

Robust health information systems (HIS) are essential components of strong health systems (12). At the most basic level, immunization registries are systems that collect and report individual-level vaccine administration record data, thus facilitating individual follow-up of vaccination status. Registries also allow for the monitoring of vaccination coverage and facilitate analysis of AEFI(s) and surveillance data to inform the design of coverage interventions and outbreak investigations. When an electronic registry has interoperability with other electronic systems – such as the case with SIMUNDU – it is considered an IIS. (13). This paper presents lessons learned from DIY’s experience implementing an IIS.

DIY is the only province in Indonesia – out of thirty-four - that uses an IIS. This work has shed light on the strengths and underlying barriers of implementing an IIS in this context. The objective of this study was to draw lessons that inform sustainable scale-up in other provinces and possibly at the national level. This study highlighted individual capacity, technical or system issues, and high workload as the major barriers to sustainability whereas management, system performance, people’s behavior, and resources emerged as the main determinants of SIMUNDU’s successful implementation, notably in improving acceptability, implementation costs, and adoption of this innovation (14).

Despite several obstacles encountered during the implementation of SIMUNDU, this study showed that this innovation was well accepted by key stakeholders involved. On one hand, data entry clerks noted that the system is rather user-friendly and allows to better organize the data and enhance its quality. On the other hand, managers noted the benefits this innovation brought about, namely in terms of the potential for cohort data to support planning and monitoring and ultimately improve immunization coverage.

Effective management - across planning, organizing, leading and controlling functions – is a crucial reason why SIMUNDU has been viable for over 5 years. Managers use their control to encourage the beliefs and actions of the staff with a dedicated and robust managerial process (15). SIMUNDU was born from the need for credible data to assist in carrying out DIY health office duties at the managerial and operational level. At the managerial level, the disease prevention and control department and the IT department collaborated in designing a system that was readily accepted by intended users. Immunization officers and IT programmers played a central role from the early stages of development through implementation with effective coordination and communication, and they were helped in this task by the full support of their respective superiors.
SIMUNDU is cost-effective in several ways. During the introductory period of its implementation, immunization programmers, IT officers, and other staff assisted in introducing SIMUNDU in all districts in the province. This was done through integrating some of the activities across programs, thus building efficiencies in terms of time and costs for both managers and staff. Sharing resources across programs was critical in the first years, for building sustainability. Additionally, SIMUNDU maintenance does not require high costs because the DIY Health Office itself has developed the system and thus possesses in-house technical skills. The IT department has the capacity to monitor and improve processes and tailor them to user needs without much additional cost.

A good program without good leadership could fail in its implementation, and even if it was initially successful, it might not be sustainable (16). In the context of SIMUNDU, support from leadership and effective management facilitated the program’s adoption. Uptake of the new system was good and all health facilities providing immunization services have successfully transitioned to SIMUNDU. The strong network of the main persons in charge of SIMUNDU also facilitated adoption. Good communication, care and attention to staff concerns positively affected staff performance. They felt they were well supported and treated kindly, and this helped them carry out their work joyfully. According to several informants, the leadership of the DIY immunization program manager played an essential role to this effect.

The monitoring and evaluation mechanisms of SIMUNDU were also important. Preferred monitoring and evaluation activities include monthly reports and direct discussion with staff during site monitoring visits. The immunization program manager suggested this approach to maintain data quality and ensure system’s sustainability. These chosen mechanisms allow program managers to assess the actual practice in the field and the challenges faced to inform decisions about the follow-up actions to be taken. These processes supported the ongoing development of and learning from SIMUNDU as a tool for data collection, analysis, and visualization, as well as the benefits for managers to carry out monitoring and evaluation. The same statement was revealed by previous research in India about the innovation of health management information systems for primary health care agrees that this can provide essential benefits (17).

Human resources are a key determinant of successful implementation of any HIS (18). People’s behavior affects how the system works, develops, and survives (19),(20). In the case of SIMUNDU, implementation was facilitated by a culture of care, established networks, and positive attitude towards data of both the program manager and IT team. From the staff’s point of view, the local culture of helping each other and doing their job correctly and responsibly translated into staff carrying out their duties with enthusiasm and high commitment. Although facilities, funding and human resources were limited, the individuals involved were highly motivated and supportive.

Despite the many strengths of SIMUNDU, some obstacles may potentially challenge its sustainability in the long term. These obstacles can be divided into human variables and technical variables. From the human variables side, unequal distribution of capacity at the operational level can result in differing levels of data quality across facilities and districts. Staff workload is another challenge needing
addressing, as their willingness to work overtime is not a sustainable strategy. System trouble was another obstacle during the introduction of SIMUNDU, but a qualified technician or developer solved it.

**Conclusion And Recommendation**

SIMUNDU is a promising innovation for the entire country, beyond DIY. There is agreement about the potential for scale-up of this IIS to other provinces. Experience of implementing this system in DIY over the past five years has shown that the benefits outweigh the challenges, and SIMUNDU has grown into a robust and yet user-friendly system. Regular training to dedicated staff to strengthen their capacity as the system evolves and is updated, and a plan for anticipating and responding to staff turnover have proven critical strategies towards sustainability. SIMUNDU's success also rests on remarkable leadership, both in creating and enabling a supportive environment and in pursuing integration with other programs to share limited resources.

Recommendations stemming from this study address three different groups of stakeholders: the DIY health office, the national government, and researchers. First, to ensure continuity and sustainability and reduce the system's dependency on the particular person or party, SIMUNDU management and maintenance should be managed by people who have competency and interest in a good reporting system. Furthermore, a human resources plan should be developed in preparation for SIMUNDU roll-out in other provinces or at national level; this is necessary to avoid vacancies when DIY province staff are seconded to other areas for mentoring support. Second, the fact that SIMUNDU emerged from an actual need of immunization programme implementers, and saw these at the front-line of its development and implementation positively impacted its feasibility and viability. This suggests that the approach to scaling up SIMUNDU should be stepwise, considering each region's specific characteristics and needs. To this effect, a readiness map and a timeline may be developed for the roll-out of SIMUNDU in a particular region. Third, further research is needed to assess the impact of SIMUNDU on immunization coverage. Based on our conversations with stakeholders, it would be particularly relevant to focus on a low-performing region and observe the impact over a 2 to 3-year time window.

**Study Limitations**

The empirical results reported herein should be considered in light of limitations. First, in the quantitative study, the result should be considered in the study sample size mainly for UPS health facility. In qualitative research that aims to explore, caution is needed in interpreting the interview results. From these results, there is still a need for in-depth studies with different approaches, such as focus group discussions to confirm the results.

**Declarations**

*Ethics approval and consent to participate*
This study was approved by the Ethical Review Board of Universitas Ahmad Dahlan, Yogyakarta, Indonesia (ethical approval code: 012005021). Before data collection began, consent to participate was obtained from research subjects (both survey and key informant interviews).

**Adherence to national and international regulations**

Not applicable

**Consent for publication**

Before data collection begins, approval that data is taken for publication purposes is obtained from research subjects (both surveys and key informant interviews).

**Availability of data and materials**

The datasets generated and or analyzed for this study can be requested to the corresponding author.

**Competing interests**

The authors declare that they have no competing interests

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**Authors’ contributions**

SS, TAW, RR, ASDN and MF designed the study. SS, TWS, SKW, SAM collected the data. SS and RR conducted data analysis. SS developed the paper with inputs and comments from MF on each draft. All authors agree with the manuscript's results and conclusions.

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**Authors' information:**

The authors alone are responsible for the views expressed in this article. They do not necessarily represent the views, decisions, or policies of the institutions affiliated with them.
References


Figures

![Figure 1](image-url)

**Figure 1**

SIMUNDU’s development and introduction
Figure 2

Strengths, potential threats, and opportunities for scale-up
Figure 3

Visual organizing framework of SIMUNDU – DIY Province, Indonesia

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- ISSMCREQChecklist.pdf
- SupplementaryfileTableS1.docx