Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Neha Acharya Date

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

By

Neha Acharya
Master of Public Health

Hubert Department of Global Health

Deborah McFarland, MPH, PhD

Committee Chair

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

By

Neha Acharya

Bachelors of Arts
University of North Carolina at Chapel Hill
2015

Thesis Committee Chair: Deborah McFarland, MPH, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2017

Abstract

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

By Neha Acharya

Objectives: Routine immunization (RI) in Nigeria requires timely and evidence-based data for programmatic change. The objective of this study is to evaluate the District Health Information Systems-2 (DHIS2) RI dashboard project in light of concepts of "health systems strengthening (HSS)" and "health systems support." Modifying the Chee et al. 2013 framework to incorporate both strengthening and supportive elements that make for long-term system gains, this evaluation determines reoccurring project components, its strengths and weaknesses, and how the components relate to the Chee et al. established HSS criteria.

Methods: This study used a modified Chee et al. methodology by observing project components' strengths and weaknesses in relation to HSS using four main criteria. Through a thematic analysis of 100 DHIS2 RI project documents and seven key informant interviews, this study reviewed project successes and weaknesses in light of its relation to the criteria.

Results: Major project components were as follows: "Coordination," "Health Workforce," "Technology and Vaccine Stock," "Quality of Data," "Sustainability," and "Government Ownership," and "Financial Resources." This analysis revealed that component successes within states that adhered to its corresponding criterion helped strengthen the system, but that weaknesses occurring in other states hindered systems progress. Supportive elements were found within the project components of "Coordination" and "Technology and Vaccine Stock," where deployed health workers from other projects were temporarily assisting the DHIS2 RI project, and laptop provisions by CDC were a short-term gain. The analysis showed that some states experienced both strengthening and supportive project components simultaneously.

Conclusions: This study has useful implications for the CDC/BMGF implementers of DHIS2 RI who invested time, money, and resources. Providing an understanding of project weaknesses, this study hopes to influence areas of improvement before the project end-date, or for future health information systems projects in similar contexts. By forming a modified framework, this study uniquely accounts for the often critical supportive elements that are necessary for strengthening systems in resource-poor areas.

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

By

Neha Acharya

Bachelors of Arts
University of North Carolina at Chapel Hill
2015

Thesis Committee Chair: Deborah McFarland, MPH, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in the Hubert Department of Global Health
2017

ACKNOWLEDGEMENTS:

This work was made possible only through the supportive instruction of the US Centers for Disease Control Global Immunization Division, and their inspiring work with the DHIS2 RI dashboard project to strengthen the Nigerian health information system. I would like to thank Sarah Pallas, my Rollins Earn and Learn supervisor and mentor, for introducing me to the team and the DHIS2 efforts within CDC. I am also immensely grateful to Chimeremma Nnadi for his project expertise and continued patience and direction.

A special thanks to my thesis chair, Dr. Deborah McFarland, who became my personal mentor since the very first day at the Rollins School of Public Health. Her contributions to the field of global health and health systems strengthening are an endless source of inspiration, and her support of this study is boundless.

Thank you to Joel Adegoke, who supported the coordination of the key informant interviews and was an incredible help to the completion of this thesis. Thank you to the key informants who spent their time providing critical information on their experience with the DHIS2 RI dashboard project, and to their admirable day-to-day work. Thank you to my parents for their support in my pursuit of an MPH, my two sisters, Neeti and Naina, for their love in all that I do, and my best friend and partner, Charlie Harless, for being my rock the past two years. Finally, special thanks to the Rollins School of Public Health Global Health Department for making a public health professional out of me.

ACRONYMS

African Field Epidemiology Network	AFENET
Bill and Melinda Gates Foundation	BMGF
Data Quality and Use Supportive Supervision	DQUSS
District Health Information Software-2	DHIS2
District Vaccination Data Management Tool	DVD_MT
Health Information Systems	HIS
Global Alliance for Vaccines and Immunizations	GAVI
International Monetary Fund	IMF
LGA Cold Chain Officer	CCO
LGA Immunization Officer	LIO
LGA Monitoring and Evaluation Officer	M&E
Local Government Authority	LGA
Low and Middle-Income Countries	LMIC
Millennium Development Goals	MDGs
National Health Management Information System	NHMIS
National Primary Health Care Development Agency	NPHCDA
National Stop Transmission of Polio	NSTOP
Organization for Economic Cooperation and Development	OECD
Primary Health Care	PHC
Research and Development	R&D
Routine Immunization	RI
Second World War	WWII
Supplemental Immunization Activity	SIA
Sustainable Development Goals	SDGs
United Nations	UN
United Nations Development Programme	UNDP
United States Agency for International Development	USAID
United Nations Children's Fund	UNICEF
US Centers for Disease Control and Prevention	CDC
World Health Organization	WHO

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

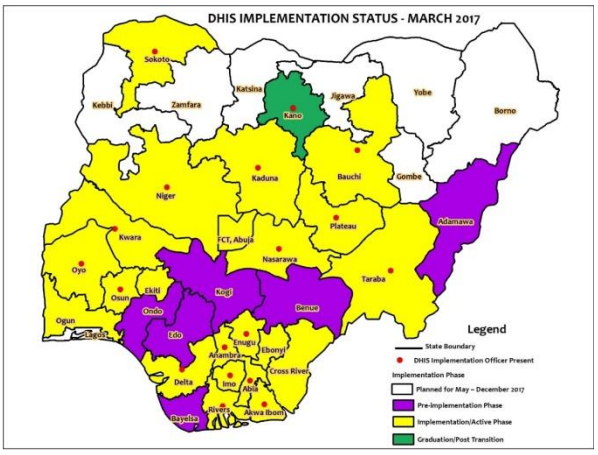
In 2007, the World Health Organization (WHO) published "Everybody's Business: Strengthening Health Systems to Improve Health Outcomes" to provide a framework for what health systems, and the concept of "health systems strengthening (HSS)," were (20). Health systems are defined as any entity consisting of "all organizations, people and actions whose primary intent is to promote, restore or maintain health (20)." The 2007 WHO publication further expounded upon the essential components that made for "health systems strengthening," defined as the improvement of essential goals for a sustainable health structure: health financing, governance, human resources for health, health information systems (HIS), medicine/technology, and service delivery (20). These six "building blocks" were outlined as critical components of a strong health system to be achieved in all countries (21). The Sustainable Development Goals (SDGs), set for 2015-2030, outlined global objectives and included an indicator relating to strengthening country health systems, stating the impetus for "[achieving] universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all (19)." Health systems support, alternatively, includes activities that "…improve services, from upgrading facilities and equipment to distributing mosquito nets to promoting healthy behaviors… [and] can be short-term and narrowly focused (32)." The Chee et al. 2013 publication specified the distinct differences between interventions labeled as "health systems strengthening" or "health systems support" using four criteria (Table 1), arguing that the two concepts are necessary in different country contexts, but that truly strengthening interventions require activities that *only* strengthen the system. This study hopes to assist project implementers of a health systems project by analyzing its activities that have strengthened, supported, or done both. Specifically, this study examines the Nigerian District Health Information System-2

(DHIS2) Routine Immunization (RI) dashboard project, intended to improve data quality and reporting for routine immunization within 27 selected states (Figure 1). The DHIS2 RI dashboard project is currently ongoing since December 2014 until December 2017. This study aims to provide useful information on current project successes and weaknesses as of March 2017 to the project implementers, the Centers for Disease Control and Prevention (CDC) and the Bill and Melinda Gates Foundation (BMGF). Such results can determine the project's current progress in its overarching goal of "[strengthening] RI data collection, reporting, and accountability systems leading to the availability and use of timely, accurate and high quality routine immunization data for effective decision-making in Nigeria" (42). Understanding the activities that provide short-term benefits, long-term benefits, or both, can be useful for CDC/BMGF and the Nigerian Ministry of Health (MoH) in addressing concerns prior to the completion of the project, and in the post-project phase. This knowledge can additionally provide valuable information on common areas of successes and struggles in HIS projects within contexts like Nigeria to implementers of similar projects in the future.

Table 1: Chee et al. Criterion for Health Systems Strengthening[32]

• Do the interventions have cross-cutting benefits beyond a single disease? • Do the interventions address policy and organizational constraints or strengthen relationships between the building blocks? • Will the interventions produce permanent systemic impact beyond the term of the project? • Are the interventions tailored to country-specific constraints and opportunities, with clearly defined rules for country institutions?

Figure 1: DHIS2 RI Implementation States in Nigeria as of March 2017



Aims and Objectives

This study aims to assess features of the DHIS2 RI dashboard project in Nigeria through distinguishing reoccurring project components, and assessing their successes and weaknesses in light of the Chee et al. criteria. Modifying the Chee et al. framework by observing the strengths and weaknesses as they relate to being strengthening, supportive, or a combination of both, this study acknowledges that projects like DHIS2 RI intending to improve health information systems in resource-poor areas require a more comprehensive analysis of its progress. Such an examination also seeks to be useful for CDC and BMGF in improving reported weaknesses from other states when adding more Nigerian states to the DHIS2 RI dashboard project.

The objectives of this study are to:

1) Explore the differences between health system strengthening and health system support within the context of the Nigeria data project,

2) Provide analytic data on the DHIS2 RI dashboard project that may contribute to reshaping implementation strategies and provide health systems strengthening indicators for current and future DHIS2 project activities in Nigeria and other settings.

Study Setting: District Health Information Software-2 (DHIS2) Routine Immunization in Nigeria

In 2013, the Nigerian government adopted the DHIS2 web-based platform to assist with poor quality RI data within the state. This electronic health information system was designed to improve data reporting, reduce data repetition, and increase MoH usage of evidence-based results. Nigeria's National Health Management Information System (NHMIS) was the existing information system used by health facilities for continuous reporting of data, but the DHIS2 platform aimed for easier transfers of data between stakeholders, and greater government

accountability from civil society. From the success of data-driven decision making in the polio eradication program, Nigerian health officials pushed for similar interventions within the field of RI in order to achieve similar gains.

In 2014, the US Centers for Disease Control and Prevention (CDC) received a grant from the Bill and Melinda Gates Foundation (BMGF) to assist the Nigerian MoH in building a sustainable DHIS2 dashboard for RI within the existing NHMIS system. The selected pilot state was Kano, due to its substantial human and material resources; as of March 2017, 14 states were in the pre-implementation phase, 22 states in the active/implementation phase, and 1 state transitioning to independence (Figure 1). The objectives of the CDC/BMGF grant were to pilot a minimum functional DHIS2 RI implementation package first in Kano, detailed in Table 2, and to provide a soft launch in additional states that ultimately concluded in a national rollout. Using an electronic dashboard system for RI data entry, analysis, and interpretation, the DHIS2 RI project enabled readily and visual information for staff within all Nigerian administrative levels: health facilities, local government areas (LGAs), states, and nationally. CDC and BMGF also obtained immediate access to RI data through the electronic dashboard. The ultimate project goal was to "[strengthen] RI data collection, reporting, and accountability systems leading to the availability and use of timely, accurate and high quality routine immunization data for effective decision-making in Nigeria" (42). This study aims to analyze the current progression of the project's target goal in strengthening the Nigerian health information system; through an understanding of areas of success and areas of necessary improvement, improvements can be made for long-term decision-making.

Table 2: Minimum Functional DHIS2 Implementation Package (42)

Package Item	Activity/Target Audience	Expected Outcomes

State advocacy meeting	• Meet with chief executives and senior staff of State Health Ministry and key agencies • Liase with partner agencies in state on scale-up plans • Sign DHIS2 MoU with state, obtain commitment to provide support and institute state-managed DHIS2 core group	State buy-in and commitment
Field assessment	• Conduct comprehensive hands-on evaluation of routine immunization project activities at four health facilities in two LGAs. • Key focus on data collection, reporting, use and feedback	Identify opportunities to improve RI and RI data systems
Investment package delivery	• Configure DHIS2 dashboard for all health facilities in the state by ward and LGA. • Based on assessment findings, provide laptop computers to LIOs and paper tools for health facilities and LGAs	Improved infrastructure and RI data reporting systems
State-level DHIS2 training	• Train state and LGA-level immunization teams and RI partners on use of DHIS2 dashboard and tools. Provide additional trainings, e.g. RI microplanning as may be identified during field assessment visits	Improved DHIS2 use capacity
LGA-level DHIS2 training	• Train HF staff on use of paper tools, routine immunization data reporting, data feedback, monthly LGA review meetings	Improved data tools use capacity. Improved health facility data quality and use
Field support staffing	• Recruit, train and deploy a	Accelerated skills transfer to

	DHIS2 implementation officer in the state to provide ongoing technical support and coordination in the state. Expected to mentor and transfer skills to a state-identified DHIS2 lead or focal person	government staff
Ongoing desk reviews	• DHIS2 data technical officers conduct joint assessment of data on the DHIS2 platform, making recommendations to state-level officials	Improved data quality and use
Data quality and use training	• Train LGA and state-level immunization teams on supportive supervision. Facilitate at least one state-wide health-facility and LGA supportive supervision activity	Improved data quality and use

CHAPTER 2: LITERATURE REVIEW

The Development of Health Systems Thinking

The United Nations (UN) was created in the aftermath of the Second World War (WWII), bringing a focus on international issues of human suffering and political strife. Global leaders, intent on rebuilding nations through cooperation and self-determination, sought an organization that would uphold universal standards of inalienable human rights. The UN, through its Charter, bound member states to a universal creed celebrating peace and security (1). In 1948, the World Health Organization (WHO) was formed as a UN technical agency to achieve "the attainment by all peoples of the highest possible level of health," and to establish global priorities in tackling pressing health concerns (2). Much of WHO's early programmes sought to address common diseases within countries suffering in the aftermath of WWII. In 1948, the first World Health Assembly, WHO's annual health policy-making forum, established six areas of focus that would shape the initial decades of work within the organization: malaria, tuberculosis, venereal diseases, maternal and child health, sanitary engineering, and nutrition (3).

WHO's "international health" agenda from 1948 to the late 1960s embarked on ambitious goals of disease eradication (5). The first attempt began under the leadership of the first Director-General, Brock Chisholm, who spearheaded the effort in 1948 to eradicate malaria from the face of the earth. In his annual report, he wrote, "by means of advice furnished by the Expert Committee on Malaria, field services and visits of individual experts, the Organization has assisted governments in carrying out malaria control…and had caused the world to think, perhaps for the first time, in terms of worldwide eradication of malaria (4)." Marcolino Candau, the second Director-General, attempted to fulfill this promise, but experienced barriers related to the inter-connectivity of malaria with varying socioeconomic contexts of each nation (5). With

the development of dichloro-diphenyl-trichloroethane (DDT), the first modern insecticide, a rising number of national control programmes began to adopt the spray (47). Its widespread application made for a feasible use in a global eradication program; though the launch of the Global Malaria Eradication Programme, approved by the 8th World Health Assembly in 1955, was largely well-received, controversy in how the programme should direct its approach caused discord (47). Advocates for eradication called for the program to quickly use DDT before mosquito resistance prevailed in hard-to-reach areas, and argued that "control" efforts were far more expensive, and less appealing. Opponents criticized the lack of incorporation of poor health system infrastructures in the approach, and argued for the severe consequences in an interrupted global eradication campaign to the population's immunity (48). The WHO Expert Committee on Malaria's campaign design ultimately focused primarily on indoor residual spraying of DDT or other insecticides, reducing investments in further malaria research, and entrusting control efforts to newer or younger malariologists as opposed to experienced ones, forming a "one-size-fits-all" approach (48, 6). As some countries reported success in achieving total coverage and others unable to access remote areas to interrupt periods of transmission, the campaign recognized the importance of capable infrastructures in addressing malaria surveillance. Immense front-end investments leading to subpar results forced implementers to understand how malaria eradication efforts "should be axiomatic to integrate environmental sanitation programmes in underdeveloped areas with general community development… (7)." After continued issues in organizing surveillance systems that addressed last malaria cases, the 1967 World Health Assembly eventually reevaluated strategies to revert back to control efforts (49).

An approach of marrying programmatic efforts with unique country health systems resurfaced when Dr. Viktor Zhdanov, Ambassador from Russia, proposed a ten-year plan for global

smallpox eradication to WHO in 1958. After comparing eradication efforts between malaria and smallpox, experts announced the latter as a more feasible candidate. The distinctive features of smallpox that enabled ease in diagnosis and freeze-dried vaccines suitable for all temperatures made eradication appear attainable, and through country support and donations, the cause gained strong momentum (8). Campaign efforts now sought to utilize existing health systems to expand program breadth and achieve eradication (9). Community health workers became critical to the success of the campaign, not just for assisting with language barriers, but also for elucidating the sociocultural contexts within their respective communities. In designing program activities to account for ill-equipped health systems by forming special teams to deliver immunization services throughout the population, the 1964 WHO Expert Committee on Smallpox was requested "to prepare a programme of advice and help countries on the basis that campaigns would be primarily the responsibility of national governments" (50). With the development of the jet injector for administering the vaccine for smallpox and growing political and budgetary support, the revised smallpox programme objective was to understand country-by-country contexts, form developed reporting systems at the onset of campaigns, and continue research on smallpox virology. As the Director-General stated in the 19th World Health Assembly in 1966, "it is necessary for the eradication programmes to develop a systematic plan for the detection of possible [smallpox] cases and concurrent investigation regarding the source and site of acquisition of the disease…even in countries with a limited local health structure, a systematic surveillance plan can and must be developed as an essential component of the eradication programme" (51). Through continuous efforts in developing country disease surveillance standards, use of regional staff in developing systems for delivering vaccinations, and WHO's Smallpox Eradication Unit later formation of an Expanded Programme on Immunization (EPI) in

1974 to tackle a group of vaccine-preventable diseases, the smallpox diseases was declared eradicated in 1979 (52).

Vertical vs. Horizontal Efforts

WHO's early efforts from 1948- late 1960s were largely vertical programmes, where "the solution of a given health problem [is addressed] through the application of specific measures through single-purpose machinery (10)." The advent of effective proxies against diseases like tuberculosis, smallpox, malaria, yellow fever, and more encouraged a number of these targeted and mission-focused efforts that lasted for a designated period of time (11). Elimination of diseases like tuberculosis in high-income countries found success with strong health structures that involved direct lines of command from central tuberculosis areas to specialty hospitals, clinics, and different teams to oversee training, health education, and research. However, similar results did not occur in low and middle-income countries (LMICs), even with the same oversight and effort. Around the late 1950s, and particularly after the malaria eradication campaign, experts began to utilize other approaches to acknowledge individual country contexts with health efforts (11). Labelled as the "father" of primary health care, WHO's third Director-General, Dr. Halfdan Mahler, addressed the systemic factors inhibiting vertical eradication approaches. Primary health care (PHC) became a defining moment for the organization to advocate for the view that a population's health was less associated with technological advances than a nation's standard of living and care. Director-General Mahler pushed forward strategies of in-country "basic health services" by directing the organization towards a comprehensive vision of health, where vertical programs became a part, but not the whole, of programme directives. In 1975, a joint WHO-United Nations Children's Fund (UNICEF) report labelled "Alternative Approaches to Meeting Basic Health Needs in Developing Countries" addressed the weaknesses of vertical

approaches that assumed an expansion of "Western" medical systems would fit dissimilar contexts. To enact a fundamental change that focused on equity, access, and affordability, WHO promulgated the Declaration of Alma-Ata, adopted by all member states in 1978. The document embraced PHC as a means for providing universal and comprehensive healthcare services that expanded beyond vertical programs to target health system gaps (12).

Alma-Ata marked an acceptance of more horizontal approaches within healthcare. Such methods were efforts to "tackle the overall health problems on a wide front and on a long-term basis… [and include] a variety of managerial or operational changes to health systems to bring together inputs, delivery, management and organization of particular service functions (10)." The fall of the Soviet Union in 1991 and the increase in decolonization and social revolutions inspired a number of these horizontal approaches (13). However, WHO began to lose global importance in the 1980s due to poor leadership and distorted priorities created by donor agendas (13). The World Bank, another multinational agency formed in the aftermath of WWII, assisted in post-war reconstruction of primarily European nations; with changing global priorities, the Bank shifted to alleviating poverty in LMICs through interest-bearing and interest-free loans and assistance in the 1980s. Then World Bank President Robert McNamara aspired to expand the organization's mandate from assisting in economic development issues to including a provision of providing all humans with opportunities for a "full life (14)." This shift involved a focus on health, highlighted prominently with the release of the *World Development Report, 1980*. The document, stressing the intersectionality between ill health with poverty, envisioned horizontal approaches like PHC and health systems development as the means of aiding marginalized populations. The *1993 World Development Report: Investing in Health* subsequently devoted its entire report to the benefits of investing in national healthcare systems. The document

highlighted country systemic issues surrounding the failure of traditional health programmes, namely being a lack of sustainable financing, a weak health workforce, and inequitable access to care. Other organizations like the International Monetary Fund and the Organization for Economic Cooperation and Development began to similarly invest in systems approaches, placing pressure on WHO to redirect priorities (15).

Prioritizing Health Systems Thinking

In 2000, WHO released its infamous World Health Report on improving health systems performance that put forward a framework for system goals, and ranked member states on a fixed set of performance measures (16). While WHO received much criticism for its purported political biases in the country ranking, the report elevated the importance of health systems within the agency (16). In 2008 during the G8 summit in Tokyo, Japan, member countries articulated a global commitment towards strengthening health systems in LMIC. The summit convened an external experts' committee tasked with providing policy recommendations for strengthening health systems through diagonal approaches, or a combination of both vertical and horizontal methods, that tackle diseases and systemic issues (17). Public-private partnerships and stakeholders like the Global Fund, the Global Alliance for Vaccines and Immunizations (GAVI), and Bill & Melinda Gates Foundation (BMGF) increased partnerships to address health systems concerns, and in 2015, the UN General Assembly formulated the Sustainable Development Goals (SDGs) to postulate the goals and indicators for the global health community to achieve by 2030. Building off the Millennium Development Goals (MDGs) intended to achieve certain health goals by 2015, the SDGs aimed to include equity in health outcomes, as well as health systems components (18). Goal 3: Indicator 3.8 directly addresses health systems by aiming to "achieve universal health coverage, including financial risk protection, access to quality essential

health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all (19).” With a goal of having all countries strive to implement national financial schemes that provide affordable healthcare for its citizens, this particular goal calls for greater efforts in the area of health systems strengthening (HSS).

Health System Strengthening Concepts

A health system is an entity consisting of “all organizations, people and actions whose primary intent is to promote, restore or maintain health (20).” As the 2007 World Health Report stated, health system goals are to improve health equity, implement affordable, accessible, and acceptable care, and provide greater coverage for all without compromising safety (20). The 2007 WHO publication further expounded upon the essential components that made for “health systems strengthening,” defined as the improvement of essential goals for a sustainable health structure. These “building blocks” include the following (20):

1) Concerned with the management of inputs, the **service delivery block** entails the organization and planning of providers, including the management and ownership on primary, secondary, and tertiary levels. Minimum characteristics that represent a “well-functioning” service delivery system include comprehensiveness, accessibility, coverage, continuity, quality, person-centeredness, coordination, accountability and efficiency (22). Policy-makers must base decisions on evidence, and a strong service delivery system incorporates a resilient monitoring methodology that measures and assesses patients and their health outcomes. While no single or standard monitoring system exists, providers must place attention on innovation, collaboration, and “person-centered” care, and the improvement of outcomes or efficiencies from such inputs (37). Policy-makers must review and analyze

multiple sources of data, such as facility assessments, censuses, and routine facility reporting systems, for the betterment of a data-driven service delivery system (22).

2) The **health workforce,** defined as "all peoples engaged in actions whose primary intent is to enhance health," is a critical component of a successful health system (23). While nations understand the prominence of a skilled, plentiful health workforce, inefficiencies and worker scarcity in LMICs are substantial. Worker migration from rural to urban areas, improper or insufficient training, unequal representation of gender, and lack of worker motivation are all factors affecting a thriving health workforce (25). Target 3c of the SDGs called to "substantially increase health financing, and the recruitment, development and training and retention of the health workforce in developing countries, especially in least developed countries and small island developing States (24)." The ability to have health workers respond immediately to pressing humanitarian emergency concerns is a critical aspect of a strong, resilient, and prepared health system. A cross-cutting agenda using not just physicians and nurses, but community-based workers like midwives and specialty practices all make for a more integrated and efficient health workforce (25).
3) The best-constructed health system cannot function without proper leadership and governance (37). **Governance**, as defined by the United Nations Development Programme (UNDP), is "the exercise of political, economic and administrative authority in the management of a country's affairs at all levels (26)." Health systems governance relates to the range of abilities and opportunities to lead, promote, and protect the health of a population. Citizens, businesses, public health organizations, non-governmental organizations, and more are the driving forces behind governance in a health system. Each country has different health risks and societal drivers, ranging from infectious diseases to air

pollution, but strong health governance provides the capability to respond in a timely fashion to all issues. Governance can also involve multiple domains, including the regulation of market failures, formatting policy, building partnerships, generating a knowledge base, and safeguarding accountability (27). Involving the rule of law, or a framework ensuring a fair enforcement for all peoples, along with transparency, inclusiveness, efficiency, and participation, a strong health governance system is able to ensure equal representation and address weaknesses found in other building blocks (27).

4) **Health financing** is the ability for governments to "raise sufficient funds for health, remove financial barriers to access, reduce financial risks of illness, and make better use of the available resources" (28). The ability for a health system to protect its citizens from burdens of rising health costs allows for "the achievement of the highest standard of health" (2). Countries finance healthcare services differently, but the vital flows of finance are the collection and pooling of revenues from citizens, donors, and organizations through taxes, distribution of pooled funds through social insurance or local authorities, payments moving from purchasers of care to providers of care, and out-of-pocket payments (37). Unfortunately, catastrophic out-of-pocket costs drive around 100 million individuals below the poverty line annually (29). Goal 3: Indicator 3.8 on universal health coverage serves as a global target to aim for robust country health systems that are financially capable of protecting citizens from burdening medical expenses.
5) The availability, acceptability, and delivery of **medical products and technologies** are a critical component of a functional health system. WHO has defined essential medicines as "those medicines that respond to the priority health needs of a specific population…[and] should be available at all times in adequate amounts, be affordable, and have a proven

efficacy, quality and safety" (30). Medicines and technology as a building block are not isolated from the other system components, but rather an integral part necessitating interconnectivity. A challenging aspect of this block is incentivizing new markets, particularly in the area of pharmaceuticals and research and development (R&D). Encouraging the development of medicines for rare diseases or diseases with small markets is an integral part of a thriving R&D environment. Health systems approaches seek integration among health financing, governance, and service delivery with medical products and technology in order to reach maximum social benefit (37).

6) **Health information systems (HIS)** are the technology behind a cohesive health system. These capabilities include emergency response, facility management, patient records management, health research, immunization records, and more. Policymakers, communities, and providers must make data-driven decisions on community health inequities, programmatic or system performance, and the health impacts of policies. A functioning health information system is able to transfer data from local levels to a top-tier national level for establishing health priorities and analyzing population changes in terms of health outcomes. Health information systems must also incorporate accurate data quality, integrity, accuracy, reliability, serviceability, and methodological soundness (31).

Health System Support

Recognizing the difference between health systems strengthening activities and health systems support activities is critical for policy-makers, funders, and future programmatic responses. Health systems support involves "any activity that improves services, from upgrading facilities and equipment to distributing mosquito nets to promoting healthy behaviors…[and] can be short-term and narrowly focused (32)." Supporting a health system is critical and indispensable at

times, particularly during post-disaster or conflict circumstances when short-term gains improve population health. Activities that classify as health system support are any increases in inputs that provisionally add value to one or more building blocks. Donor support and narrowly-focused efforts tend to provide short-term gains, but leave long-term gaping holes for the host country to address in the future (33). However, activities that provide short-term gains may be necessary in order for a country to reach a strengthened system. Projects, typically externally financed with short timelines, may enact supportive activities, and incorporate provisions for transitioning activities to national control, that can help bolster efforts in strengthening a health system.

Vaccine Health Information Systems

A health information system, or an "integrated effort to collect, process, report and use health information and knowledge to influence policy-making, programme action and research," serves as the backbone to public health work (34). Such systems collect data on patient health status, demographics, costs, health infrastructure inputs, and inequities, with the intent of influencing programmatic response. Without sufficient and quality information on population health demographics, as well as healthcare utilization, pertinent actors like country Ministers of Health, non-governmental actors, and donor agencies cannot close system gaps. Agencies and public-private partnerships like the World Bank, United States Agency for International Development (USAID), and UNICEF assisted in the development of international standards for survey and data management programmes, largely after the MDGs brought such issues to light (35). However, a functioning health information system requires motivation from country leadership to enable adequate investments in not just the development of technological infrastructure, but increases in the health workforce to collect and analyze health data. Integrating a health

information system with the five other building blocks is critical for health system durability; failure to undertake evidence-based approaches leads to incomplete decision-making (45).

For example, information systems used in national vaccination programs are critical to the achievement of high vaccine coverage rates. Vaccinations, considered the greatest contribution to public health, avert roughly two to three million child deaths per year from preventable diseases like diphtheria, tetanus, pertussis, and more (40). A lack of investments in protecting against vaccine-preventable diseases affects the total country health outcomes, and severely strains economic performance (46). Routine immunization (RI) practices are the "sustainable, reliable and timely interaction between the vaccine, those who deliver it and those who receive it to ensure every person is fully immunized against vaccine-preventable diseases (36)." Specifically, a RI information system compiles data on population vaccine doses to allow for clinical recommendations, advances in overall coverage, and health improvements among the population. In 2000, WHO initiated a process of annually estimating routine vaccination coverages on a global, state, and local level that included diphtheria, tetanus, pertussis, polio, and measles-containing vaccines. The reported estimates came from government information systems providing regular surveys and retrospective reviews to create a comprehensive view of vaccination coverage in their country (38). Such data were also used to gain an estimate of not only global achievements towards vaccine coverage goals, but also an understanding of the performance gaps in national immunization information systems (39). Access to immunization services, a sufficient and trained health workforce, committed leadership, vaccine development, and service delivery systems to marginalized populations all correspond to a functional and durable immunization information system. With the advantage of real-time data through aspects like an electronic medical record enabling easy transfer of information from local to national

levels, durable health information systems can influence decision-makers at all government levels. Understanding the impact of RI immunization program efforts, necessary future progress, and coverage of the socially or geographically marginalized allows for continued evidence-based policy efforts for better health outcomes (41).

District Health Information Software-2 (DHIS2) Routine Immunization in Nigeria

In 2013, the Nigerian government adopted the District Health Information System-2 (DHIS2) to assist with poor quality RI delivery data. This electronic health scheme was designed to improve data reporting, reduce data repetition, and increase MoH usage of evidence-based results. Nigeria's National Health Management Information System (NHMIS) was the existing information system used by health facilities for continuous reporting of data, but the DHIS2 platform aimed for easier transfers of data between stakeholders, and greater accountability from civil society to government. From the success of data-driven decision making in the polio eradication program, Nigerian health officials pushed for similar interventions within the field of RI to enact similar gains.

In 2014, the US Centers for Disease Control and Prevention (CDC) received an initial million-dollar grant from the Bill and Melinda Gates Foundation (BMGF) to assist the Nigerian Ministry of Health in building a sustainable DHIS2 RI dashboard within the existing NHMIS system. The selected pilot state was Kano, due to its substantial human and material resources; as of March 2017, 14 states were in the pre-implementation phase, 22 states in the active/implementation phase, and 1 state transitioning to independence (Figure 1). The objectives of the CDC/BMGF grant were to pilot a minimum functional DHIS2 RI implementation package first in Kano (Table 1), and to provide a soft launch in additional states that ultimately concluded in a national rollout.

Figure 1: DHIS2 RI Implementation States in Nigeria as of March 2017

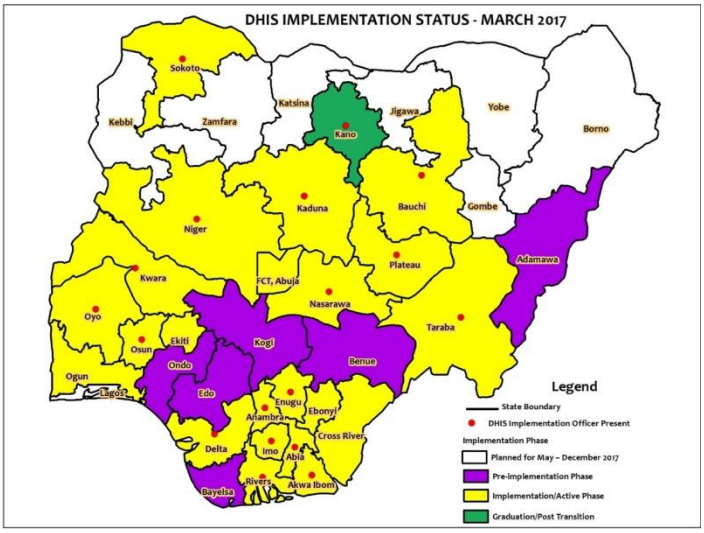


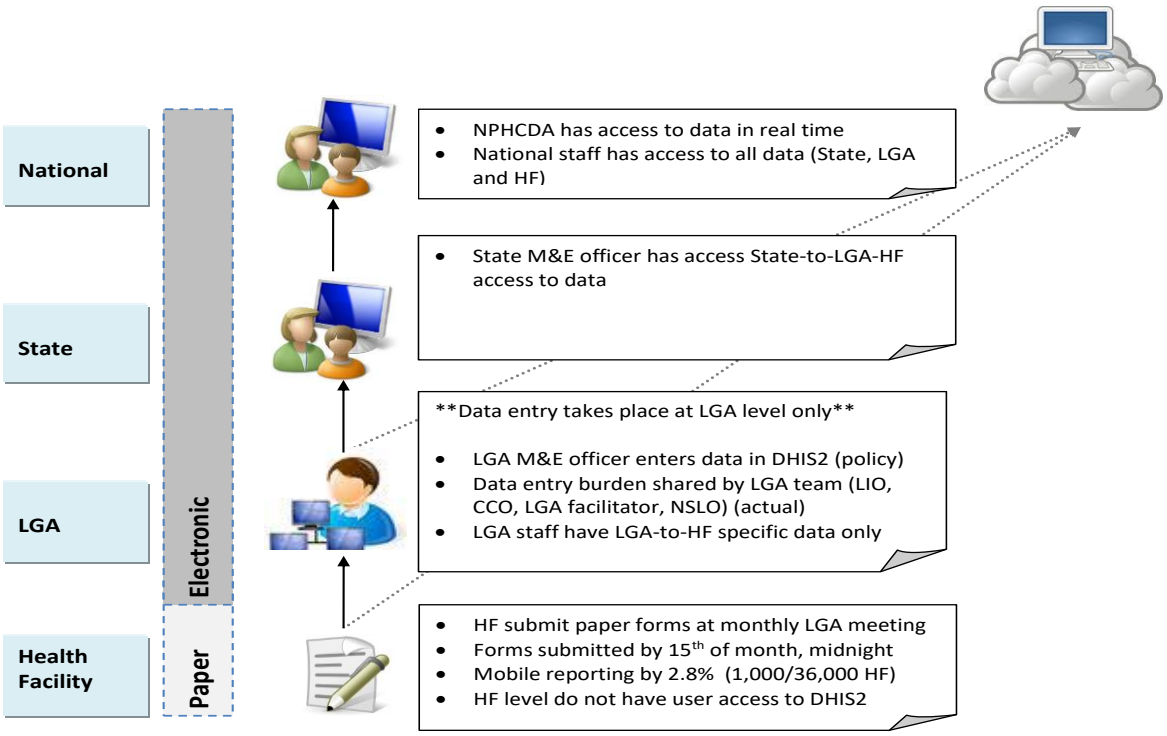
Table 1: Minimum Functional DHIS2 Implementation Package (42)

Package Item	Activity/Target Audience	Expected Outcomes
State advocacy meeting	• Meet with chief executives and senior staff of State Health Ministry and key agencies • Liase with partner agencies in state on scale-up plans • Sign DHIS2 MoU with state, obtain commitment to provide support and institute state-managed DHIS2 core group	State buy-in and commitment
Field assessment	• Conduct comprehensive hands-on evaluation of routine immunization project activities at four health facilities in two LGAs. • Key focus on data collection, reporting, use and feedback	Identify opportunities to improve RI and RI data systems
Investment package delivery	• Configure DHIS2 dashboard for all health facilities in the state by ward and LGA.	Improved infrastructure and RI data reporting systems

	• Based on assessment findings, provide laptop computers to LIOs and paper tools for health facilities and LGAs	
State-level DHIS2 training	• Train state and LGA-level immunization teams and RI partners on use of DHIS2 dashboard and tools. Provide additional trainings, e.g. RI microplanning as may be identified during field assessment visits	Improved DHIS2 use capacity
LGA-level DHIS2 training	• Train HF staff on use of paper tools, routine immunization data reporting, data feedback, monthly LGA review meetings	Improved data tools use capacity. Improved health facility data quality and use
Field support staffing	• Recruit, train and deploy a DHIS2 implementation officer in the state to provide ongoing technical support and coordination in the state. Expected to mentor and transfer skills to a state-identified DHIS2 lead or focal person	Accelerated skills transfer to government staff
Ongoing desk reviews	• DHIS2 data technical officers conduct joint assessment of data on the DHIS2 platform, making recommendations to state-level officials	Improved data quality and use
Data quality and use training	• Train LGA and state-level immunization teams on supportive supervision. Facilitate at least one state-wide health-facility and LGA supportive supervision activity	Improved data quality and use

Paper-based data collection and reporting still continued at the health facility level, so the DHIS2 RI dashboard project aimed to improve manual data reporting and methodology for ease of transfer to the electronic system. For instance, the project worked with country stakeholders like the National Primary Health Care Development Agency (NPHCDA) and developmental agency partners to condense current paper tools into three documents: health facility vaccine utilization summary form, the NHMIS supplementary form, and the health facility micro-plan form. The LGA officers received training on these forms to enter information into their respective DHIS2 platform that aggregated to all levels of government and stakeholders. DHIS2 Implementation Officers from the African Field Epidemiology Network (AFENET)/National Stop Transmission of Polio (NSTOP), a stakeholder critical in providing supportive supervision activities, training sessions, and data quality checks, assists the state and LGA workforce to achieve competence on the use of the DHIS2 RI platform. Figure 2 details the data flow of the DHIS2 RI dashboard project from the health facility level to the national level. All officials have password-protected access to the dashboard, providing a visualization of RI data for decision-making and an observation of trends at the local and state level.

Figure 2: DHIS2 RI dashboard project data flow entry from health facility to national level (42)



Staff training was another project focus through a three-modular training implementation on the revised RI paper-based tools, the DHIS2 platform, and proper data quality, use and supportive supervision. During pre-implementation assessments, key priority RI areas were identified to include in trainings, like micro-planning and targeted user groups. The first user group was national and state-level officials whose job is to train fellow health workers, supervise, and troubleshoot technical problems. The second user group was RI staff teams at the state and LGA levels that included the LGA Cold Chain Officer (CCO), the LGA Immunization Officer (LIO), and the LGA Monitoring and Evaluation (M&E) Officer, along with RI supervisory staff of state health agencies and the NPHCDA zonal staff. Developmental agency staff involved at the state and LGA levels also participated in such trainings. The third user group was the health facility workers who create and send RI paper-based data information to the LGA staff. To ensure

continuous training and involvement, state DHIS2 implementation officers were stationed to provide refresher trainings for state and LGA RI teams.

The DHIS2 RI dashboard project placed three data quality checks for ensuring a continuous system of data analysis, entry, and review at all levels. The first check was to place a number of validation rules in the DHIS2 platform to limit data entry errors. The second check was for NPHCDA and the NSTOP teams to conduct regular desk reviews of data entry at state and national levels in order to flag and address potential errors and inconsistencies. The last check was to schedule site visits and qualitative field studies to detect improvements and issues in data quality and management. CDC purchased one laptop per LGA for states without sufficient technological capacity, in order for LGAs to meet their RI data entry and analysis needs. However, challenges persist in areas with limited internet connectivity and with some health facilities refusing to use the new paper tools. With the ultimate goal of government ownership of the RI data system through directly managed processes by the Nigerian government, the DHIS2 RI project aims to improve long-term immunization decision-making processes.

Chee et al. Framework and Subsequent Study Designs

A framework to distinguish between health systems strengthening and health systems support efforts within interventions was developed by Chee et al. (32). The 2013 publication formulated four criteria (Table 2) that addressed WHO's six building blocks in relation to performance drivers like behavior, policies, and regulations, arguing that implementers failing to distinguish between activities that strengthen or support a system can incur unmet expectations. The four criteria aim to illustrate the interactions between the six building blocks, and the "depth" of each block that accounts for individual country context, when analyzing an intervention.

Table 2: Chee et al. Criterion for Health Systems Strengthening[32]

• Do the interventions have cross-cutting benefits beyond a single disease? • Do the interventions address policy and organizational constraints or strengthen relationships between the building blocks? • Will the interventions produce permanent systemic impact beyond the term of the project? • Are the interventions tailored to country-specific constraints and opportunities, with clearly defined rules for country institutions?

Chee et al. argues that public health interventions must incorporate these four criteria in order to strengthen a health system over a long-term period. The article states that supportive activities help a country health system in the interim, but those activities fail to improve a system's ability to respond to future challenges independently. Researchers adopting the Chee et al. framework analyzed an ambulatory tuberculosis treatment intervention in Uzbekistan, in order to understand the health-system related challenges of the pilot project (53). Throughout semi-structured interviews of key informants, answers to the criteria questions from Table 2 that were "Yes" were coded as "health systems strengthening"; otherwise answers were coded as "No." Study results indicated that the intervention activities lay in three main themes: health systems strengthening, health systems support, and available resources. The study showed that HSS activities of dis-incentivizing ambulatory tuberculosis treatment hindered project scale-up. The current financing of tuberculosis services, where funding structures were unresponsive to growing numbers of patients, and inpatient/outpatient care budgets were unable to be reallocated to expand ambulatory services, prevented the project's ability to scale-up services. Supportive activities of requiring ambulatory staff to pay for transportation between facilities proved also a barrier in scaling-up to areas where health workers were not financially able. Finally, key informants reported a need to combine strengthening and supportive activities to provide resources that alter the Uzbekistan hospital-based system when scaling-up ambulatory tuberculosis programs.

CHAPTER 3: MANUSCRIPT

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

Neha Acharya[1]

[1] Hubert Department of Global Health, Emory University, Atlanta, USA

Author for Correspondence:
Neha Acharya, MPH_C
Hubert Department of Global Health
Rollins School of Public Health
1518 Clifton Road NE
Atlanta, GA 30322
Tel: 336-409-4176
Nehaacharya37@gmail.com

STUDENT CONTRIBUTION:

The student designed protocol and research methods, obtained Institutional Review Board approval for study conduct, conducted key informant interviews, analyzed results, and wrote all drafts and tables of the manuscript.

ABSTRACT

Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the Nigeria Routine Immunization dashboard project.

By Neha Acharya

Objectives: Routine immunization (RI) in Nigeria requires timely and evidence-based data for programmatic change. The objective of this study is to evaluate the District Health Information Systems-2 (DHIS2) RI dashboard project in light of concepts of "health systems strengthening (HSS)" and "health systems support." Modifying the Chee et al. 2013 framework to incorporate both strengthening and supportive elements that make for long-term system gains, this evaluation determines reoccurring project components, its strengths and weaknesses, and how the components relate to the Chee et al. established HSS criteria.

Methods: This study used a modified Chee et al. methodology by observing project components' strengths and weaknesses in relation to HSS using four main criteria. Through a thematic analysis of 100 DHIS2 RI project documents and seven key informant interviews, this study reviewed project successes and weaknesses in light of its relation to the criteria.

Results: Major project components were as follows: "Coordination," "Health Workforce," "Technology and Vaccine Stock," "Quality of Data," "Sustainability," and "Government Ownership," and "Financial Resources." This analysis revealed that component successes within states that adhered to its corresponding criterion helped strengthen the system, but that weaknesses occurring in other states hindered systems progress. Supportive elements were found within the project components of "Coordination" and "Technology and Vaccine Stock," where deployed health workers from other projects were temporarily assisting the DHIS2 RI project, and laptop provisions by CDC were a short-term gain. The analysis showed that some states experienced both strengthening and supportive project components simultaneously.

Conclusions: This study has useful implications for the CDC/BMGF implementers of DHIS2 RI who invested time, money, and resources. Providing an understanding of project weaknesses, this study hopes to influence areas of improvement before the project end-date, or for future health information systems projects in similar contexts. By forming a modified framework, this study uniquely accounts for the often critical supportive elements that are necessary for strengthening systems in resource-poor areas.

Key Words: health systems strengthening, systems, support, Nigeria, routine immunization, health systems policy

INTRODUCTION

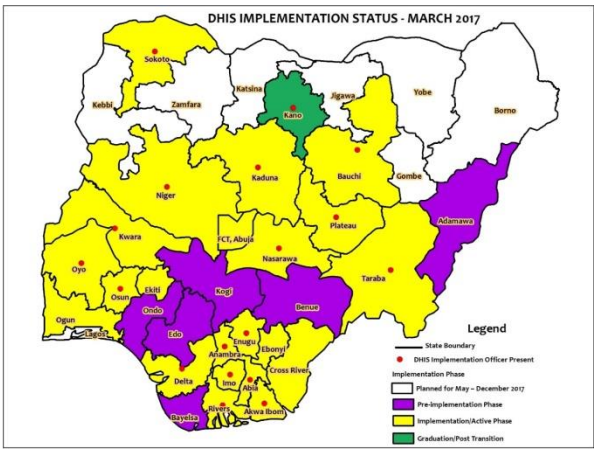
In 2007, the World Health Organization (WHO) published "Everybody's Business: Strengthening Health Systems to Improve Health Outcomes" to provide a framework for what health systems, and the concept of "health systems strengthening (HSS)," were (20). Health systems are defined as any entity consisting of "all organizations, people and actions whose primary intent is to promote, restore or maintain health (20)." The 2007 WHO publication further expounded upon the essential components that made for "health systems strengthening," defined as the improvement of essential goals for a sustainable health structure: health financing, governance, human resources for health, health information systems (HIS), medicine/technology, and service delivery (20). These six "building blocks" were outlined as critical components of a strong health system to be achieved in all countries (21). The Sustainable Development Goals (SDGs), set for 2015-2030, outlined global objectives and included an indicator relating to strengthening country health systems, stating the impetus for "[achieving] universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all (19)." Health systems support, alternatively, includes activities that "…improve services, from upgrading facilities and equipment to distributing mosquito nets to promoting healthy behaviors… [and] can be short-term and narrowly focused (32)." The Chee et al. 2013 publication specified the distinct differences between interventions labeled as "health systems strengthening" or "health systems support" through a set of four criteria (Table 1), arguing that the two are necessary in different country contexts, but that truly strengthening interventions require activities that *only* strengthen the system. Instead, this study hopes to assist project implementers of a health systems project by analyzing its activities that have strengthened,

supported, or done both. Specifically, this study examines the Nigerian District Health Information System-2 (DHIS2) Routine Immunization (RI) dashboard project, intended to improve data quality and reporting for routine immunization within 27 selected states (Figure 1). Though the DHIS2 RI dashboard project is currently ongoing since December 2014 until December 2017, this study aims to provide useful information on current project successes and weaknesses as of March 2017 to the project implementers, the Centers for Disease Control and Prevention (CDC) and the Bill and Melinda Gates Foundation (BMGF). Such results can determine the project's current progress in its overarching goal of "[strengthening] RI data collection, reporting, and accountability systems leading to the availability and use of timely, accurate and high quality routine immunization data for effective decision-making in Nigeria" (42). Understanding the activities that provide short-term benefits, long-term benefits, or both, can be useful for CDC/BMGF and the Nigerian Ministry of Health (MoH) in addressing concerns prior to the completion of the project. This knowledge can additionally provide valuable information on common areas of successes and struggles in HIS projects within contexts like Nigeria to implementers of similar projects in the future.

Table 1: Chee et al. Criterion for Health Systems Strengthening[32]

• Do the interventions have cross-cutting benefits beyond a single disease? • Do the interventions address policy and organizational constraints or strengthen relationships between the building blocks? • Will the interventions produce permanent systemic impact beyond the term of the project? • Are the interventions tailored to country-specific constraints and opportunities, with clearly defined rules for country institutions?

Figure 1: DHIS2 RI Implementation States in Nigeria as of March 2017



Aims and Objectives

This study aims to assess features of the DHIS2 RI dashboard project in Nigeria through distinguishing reoccurring project components, and assessing their successes and weaknesses in light of the Chee et al. criteria. Modifying the Chee et al. framework by observing the strengths and weaknesses as they relate to being strengthening, supportive, or a combination of both, this study acknowledges that projects like DHIS2 RI intending to improve health information systems in resource-poor areas require a more comprehensive analysis of its progress. Such an examination also seeks to be useful for CDC and BMGF in improving reported weaknesses from other states when adding more Nigerian states to the DHIS2 RI dashboard project.

The objectives of this study are to:

1) Explore the differences between health system strengthening and health system support within the context of the Nigeria data project,

2) Provide analytic data on the DHIS2 RI dashboard project that may contribute to reshaping implementation strategies for current and future DHIS2 project activities in Nigeria and other settings.

Study Setting: District Health Information Software-2 (DHIS2) Routine Immunization in Nigeria

In 2013, the Nigerian government adopted the DHIS2 web-based platform to assist with poor quality RI data within the state. This electronic health information system was intended to improve data reporting, reduce data repetition, and increase MoH usage of evidence-based results. Nigeria's National Health Management Information System (NHMIS) was the existing information system used by health facilities for continuous reporting of data, but the DHIS2 platform aimed for easier transfers of data between stakeholders, and greater accountability from

civil society to the government. From the success of data-driven decision making in the polio eradication program, Nigerian health officials pushed for similar interventions within the field of RI in order to achieve similar gains.

In 2014, the US Centers for Disease Control and Prevention (CDC) received a grant from the Bill and Melinda Gates Foundation (BMGF) to assist the Nigerian MoH in building a sustainable DHIS2 dashboard for RI within the existing NHMIS system. The selected pilot state was Kano, due to its substantial human and material resources; as of March 2017, 14 states were in the pre-implementation phase, 22 states in the active/implementation phase, and 1 state transitioning to independence (Figure 1). The objectives of the CDC/BMGF grant were to pilot a minimum functional DHIS2 RI implementation package first in Kano, detailed in Table 1, and to provide a soft launch in additional states that ultimately concluded in a national rollout. Using an electronic dashboard system for RI data entry, analysis, and interpretation, the DHIS2 RI project enabled readily and visual information for staff within all Nigerian administrative levels: health facilities, local government areas (LGAs), states, and nationally. CDC and BMGF also obtained immediate access to RI data through the electronic dashboard. With the ultimate goal of government ownership of the RI data, the DHIS2 RI dashboard project aims to improve long-term immunization decision-making processes. This study aims to analyze the current progression of the project's target goal in strengthening the Nigerian health information system; through an understanding of areas of success and areas of necessary improvement, improvements can be made for long-term decision-making.

Table 2: Minimum Functional DHIS2 Implementation Package (42)

Package Item	Activity/Target Audience	Expected Outcomes
State advocacy meeting	• Meet with chief executives and senior staff of State	State buy-in and commitment

	Health Ministry and key agencies • Liase with partner agencies in state on scale-up plans • Sign DHIS2 MoU with state, obtain commitment to provide support and institute state-managed DHIS2 core group	
Field assessment	• Conduct comprehensive hands-on evaluation of routine immunization project activities at four health facilities in two LGAs. • Key focus on data collection, reporting, use and feedback	Identify opportunities to improve RI and RI data systems
Investment package delivery	• Configure DHIS2 dashboard for all health facilities in the state by ward and LGA. • Based on assessment findings, provide laptop computers to LIOs and paper tools for health facilities and LGAs	Improved infrastructure and RI data reporting systems
State-level DHIS2 training	• Train state and LGA-level immunization teams and RI partners on use of DHIS2 dashboard and tools. Provide additional trainings, e.g. RI microplanning as may be identified during field assessment visits	Improved DHIS2 use capacity
LGA-level DHIS2 training	• Train HF staff on use of paper tools, routine immunization data reporting, data feedback, monthly LGA review meetings	Improved data tools use capacity. Improved health facility data quality and use
Field support staffing	• Recruit, train and deploy a DHIS2 implementation officer in the state to	Accelerated skills transfer to government staff

	provide ongoing technical support and coordination in the state. Expected to mentor and transfer skills to a state-identified DHIS2 lead or focal person	
Ongoing desk reviews	• DHIS2 data technical officers conduct joint assessment of data on the DHIS2 platform, making recommendations to state-level officials	Improved data quality and use
Data quality and use training	• Train LGA and state-level immunization teams on supportive supervision. Facilitate at least one state-wide health-facility and LGA supportive supervision activity	Improved data quality and use

METHODS

Study Design

Chee et al. identified four main criteria that distinguished the concepts of health systems strengthening from systems support. The Chee et al. framework was formed to identify areas within project activities labelled as either HSS or health systems support, in order to influence project design and implementation. This study instead aims to incorporate an altered Chee et al. framework in which both health systems strengthening and support can simultaneously occur in projects. Thus, a thematic analysis was conducted of all DHIS2 RI project documents and key informant interviews to determine reoccurring project components, the Chee et al. criterion it corresponds with, component strengths and weaknesses, and how each component relates to the criterion in either strengthening, supporting, or both strengthening and supporting the Nigerian health information system. Documents included the project grant proposal, state monitoring and

evaluation (M&E) plans, project updates, state annual reports, LGA and health facility-level training reports, health facility-level advocacy and assessment visit reports, monthly summary reports, DHIS2 call summaries, zonal updates, RI bulletins, weekly project reports, and narrative reports from all implementation states (46). Only those statements from documents discussing project successes and weaknesses were reviewed, as opposed to normative statements on what the project aspired to achieve. Successes were defined by the primary investigator (PI) as any improvements in the project, and weaknesses were defined as issues seen within implementation. One hundred documents were analyzed, and seven key informants were interviewed to supplement findings and provide experienced, nuanced, and impartial viewpoints of the DHIS2 RI dashboard project. The interview guide (Appendix 1) was reviewed by and declared except from Emory University's Institutional Review Board.

Study Participants

Key informants were selected based on their experience with the DHIS2 RI dashboard project; specifically, all participants were manager-level staff with over one year of full-time DHIS2 RI project experience. A project implementation agency member who listed all eligible staff fitting the above criteria scheduled the seven phone interviews. Key informants were asked about their project roles, the successes and weaknesses of the project, and thoughts on sustainability of project activities. Four DHIS2 implementation officers from African Field Epidemiology Network (AFENET)/National Stop Transmission of Polio (NSTOP), and three M&E officers from the National Primary Health Care Development Agency (NPHCDA) were interviewed. All interviews were conducted by phone; the phone calls lasted from 30-60 minutes each.

Data Collection

All project documents were collected from the Centers for Disease Control and Prevention's (CDC) online server, which contained duplicated DHIS2 RI project documents from the December 2014 to present-day. Documents from December 2014 to March 2017 were downloaded onto a personal hard-drive for ease of analysis, since there was no personal information that indicated privacy concerns. Consent was sought for all key informant interviews, beginning first through email communication between the key informant and PI, and later through a signed emailed consent form prior to the interview. Each key informant was English-speaking and over 18 years of age. No medical information or personal identifiers were asked for or recorded. Consent material was verbally summarized before the interview to thoroughly explain study contents. All phone calls were recorded as an audio file and destroyed after transcription was complete. There were no financial incentives for key informant participation.

Data Management and Analysis

All written and audio files were stored onto the private server within the CDC Atlanta campus, and backed up through an external hard-drive. The PI transcribed recorded interviews and analyzed all project documents. Using a thematic analysis approach, or "a method for identifying, analyzing, and reporting patterns within data (42)," each of the Chee et al. criteria was assigned a color into an Excel spreadsheet, and defined in detail as it relates to the DHIS2 RI dashboard project. Then, all statements from the documents and transcriptions that discussed project features, successes, or weaknesses were reviewed, and reoccurring project components were established. These components were assigned a color based on their definitional relation to one of the four Chee et al. criteria. Then, each statement was coded as "0" or "1" to indicate project weaknesses or successes, respectively. Example statements demonstrating project

weaknesses included “late reporting,” “major challenge identified was data discrepancy between registers and summary forms,” and “poor commitment of LGA team in improving their knowledge of the dashboard.” Statements demonstrating project successes included “good political commitment,” “regular monitoring of sessions by partners and government officials from the national, state, and LGA level,” and “optimistic health workers at the LGA level.” By identifying the reoccurring DHIS2 RI project components, the PI observed all stated strengths and weaknesses of each as it related to its corresponding Chee et al. criterion.

RESULTS

Table 3 shows the reoccurring project components found from the analysis with its respective color-coded Chee et al. criteria.

Table 3: Main Criteria and Corresponding DHIS2 RI Project Components

Chee et al. Criteria	Criteria Descriptions in the RI DHIS2 Project Context	Chosen Themes
Do the interventions have cross-cutting benefits beyond a single disease?	Cross-cutting benefits include efforts in HIV/AIDS, malnutrition, diabetes, and other health programs improving or spilling over in any given way due to the RI DHIS2 program.	• Coordination
Do the interventions address policy and organizational constraints or strengthen relationships between the building blocks?	Interventions must involve project aspects addressing current governmental, judicial, or political constraints in Nigeria. Interventions may also address improving functions of the governance, health workforce, medicine, supply chain, and financing blocks with one another.	• Health Workforce • Technology and Vaccine Stock • Quality of Data
Will the interventions produce permanent systemic impact beyond	The intervention clearly indicates long-term effects	• Sustainability

the term of the project?	beyond the project end date, either regarding mention of continuity or activities after the completion of project grand funds.	
Are the interventions tailored to country-specific constraints and opportunities, with clearly defined rules for country institutions?	DHIS2 RI project components are specifically acknowledging the environment, culture, and constraints of Nigeria, and/or acknowledges clear implementation policies for stakeholders involved.	• Government Ownership • Financial Resources

Project Component 1: Coordination

The first DHIS2 RI project component of "coordination," defined as project functions incurring benefits that spill over into other health programs (54), was prominent throughout documents and interviews. This component was relevant under the Chee et al. first criterion, where activities had "cross-cutting benefits beyond a single disease (32)." For example, Nasarawa, Kano, and Akwa Ibom project documents reported that DHIS2 RI incorporated existing "harmonized data quality and use supportive supervision (DQUSS) tools, indicating a merger in health information efforts in the state to avoid ineffective duplication." Coordination among partner agencies affiliated with the project improved between December 2014-March 2017, with Nasarawa and Oyo reporting greater motivation from stakeholders like WHO, United Nations Children's Fund (UNICEF), Clinton Health Access Initiative, the European Union, and NPHCDA partner staff to discuss buy-in in other Nigerian health projects. Statements also indicated that officers in Nasarawa and Plateau were deployed from polio response teams to bring technical expertise to the dashboard, and that the state health department chiefs aimed to integrate other health efforts with the RI dashboard to create a "national redesign…to optimize cold chain storage capacity and efficiency." Six out of seven key informants responded that the RI dashboard had positively

affected data reporting processes in other national health priority areas. One respondent stated that, “we also [now have] supplemental immunization activity (SIA) officers at the state level and LGA level who have programmed data at different levels [with the RI module], and since their capacities are in data entry, data management, and other data-related issues, they impact other interventions.” Another respondent said that, “…under NHMIS, we have a lot of data elements that cover malaria, maternal health, HIV, and a lot of other health services…I could remember before I joined, I was on a program that used DHIS2 to analyze maternal health data, [since] DHIS2 is beyond RI… [The RI module] has expanded or strengthened the DHIS2, so we have a lot of other health services in it.” Statements further explained that health workers involved with the DHIS2 RI project were also involved in other DHIS health platforms, and RI training in the timeliness, completeness, and quality of data translated well into other health information projects. These states reporting such successes in coordinating activities fulfilled the terms of the first criterion by incurring health benefits beyond just RI, helping to strengthen the system. However, some weaknesses from other states were made apparent from Bauchi, Sokoto, and Oyo, where multiple RI activities were ongoing in the state and often conflicting with one another. For instance, one statement from Sokoto said that there was a “clash of NSTOP activities with [the] partners’ schedules,” and from Bauchi that there was “nonparticipation of some RI service providers due to other interventions.”

Project Component 2: Health Workforce

Trainings

The component of “health workforce” refers to the capacity of health workers in enacting project activities as expressed by project implementers and stakeholders. This component was relevant under the Chee et al. second criterion, where activities must “[strengthen] relationships between the building blocks.” With the health workforce also being a WHO building block in

strengthening a system, the DHIS2 RI project intended to heavily integrate this component with the Nigerian health information system. The analysis found that under the umbrella term of "health workforce," trainings were stated prevalently. Trainings were defined as any effort to instruct or guide incoming and existing health workers on their roles, knowledge, overall project objectives, and refresher activities (55). Statements from documents largely agreed that the institutionalized trainings held for LGA Immunization Officers (LIOs), LGA Cold Chain Officer (CCO), Monitoring and Evaluation (M&E) officers, RI providers, state data managers, NHMIS officers, and state MoH staff were successful project attributes. Training activities that were focused on were reports generation from the DHIS2 RI dashboard, conducing facility-based reports, maintaining mobile phones, collecting data, using updated RI data tools, and re-training. Sokoto, Enugu, Taraba, Abia, Akwa Ibom, and Bauchi mentioned "on-the-job trainings" and "refresher courses" as successful in providing facility and LGA workers useful and regular information on data entry concerns. Exercises, case studies, and scenarios were regularly used to enhance some sessions in Sokoto. Enugu and Kano also reported the successful regular assistance of LGA workers in data entry, generation of reports in health facilities, and training senior level executives within states on conducting effective supportive supervision. A key informant said that, "Before the DHIS2 RI module, there [were] a lot of issues with training of staff. When we came, there were a lot of staff not trained….because of high attrition rate, a lot of them had retired, some are moved on…so we had to do a lot of staff capacity building." However, weaknesses were reported in those very states, where statements indicated less than average data quality results due to unproductive or uninformative sessions. Some LGAs within Bauchi complained of a lack of refresher trainings, quality sessions, standard formatting of sessions, and sessions that were long enough for workers to grasp concepts. Lackluster trainings

resulted in observed knowledge gaps on the utilization and importance of the revised RI data tools. Common complaints from LGA-level staff on health facilities were poor knowledge on the use of laptops and computers, and overworked staff that made scheduling for training sessions difficult. A key informant reported that "[most] issues are understanding the tools. That might be because of [retirement]…staff attrition. Some staff [are] deployed…and left…which is another issue." Knowledge gaps were reported on not just RI tools and proper documentation of data, but basic case definitions of priority diseases.

Attitudes

Poor attitudes by the health workers were generally seen as weaknesses in the DHIS2 RI project. Non-compliance was reported in several wards, and ongoing political elections caused workers to not attend their assigned duties for extended periods. Staff unions were influential in the attitudes and commitment of workers, and regular absenteeism increased staff shortages and workload. As a key statistician from NPHCDA put it, "…we have a lot of issues that I personally think are affecting quality…we have a three-month salary and [health facility workers] are not working. [At the] state-level they pay in like six months and they are working. So for me I think the difference is commitment, and also…knowledge brings about commitment. When you are not knowledgeable, you will not be that committed." Nonpayment of salaries at the health facility level were another issue for health workers, reported in Oyo, Nasarawa, Osun, Sokoto, and Enugu, that caused worker strikes, high numbers of dropouts, and inadequate engagement in trainings. One informant on the topic of salaries said that, "You know in some places, the LIO officers ask to pay them before they enter data into the DHIS2. But when we came, we should [tell] them this is a state project…[we must] avoid monetizing things because when you give them money to do this, give them money to do that, and knowing that the government will not

continue that when you leave, it's two different things." Another said that behavior change must occur through trainings, where workers have negative opinions of stakeholders coming into the country and by "… [thinking] what is it for us…these are these that needs to change. People need to understand that to strengthen the system, you need to play your part and contribute." Successes, however, were reported in Kano, Abia, and Bauchi where workers at the health facility and LGA level were reported to being "optimistic," "committed," "passionate," and "willing to work," due to the state governments' high-level commitment towards the success and acceptance of the project. Though a number of statements reported successes with states implementing trainings, those same states also reported poor attitudes, knowledge gaps, and low retention rates that ultimately doesn't fulfill the second criterion of strengthening the two building blocks.

Project Component 3: Technology and Vaccine Stock

The component of "technology," defined in the case of the DHIS2 RI project as available internet, laptops, and phones, along with vaccine stock that accounts for cold chain equipment (CCE) and storage, were largely reported to have weaknesses. This component was classified under the Chee et al. second criteria where activities must address "policy or organizational constraints;" the analysis indicated that poor internet coverage and lack of vaccines within some facilities were an organizational constraint of the health system that affected other health projects. For instance, facilities in Enugu, Oyo, Sokoto, Osun, and Abia all reported concerns with internet connectivity, technical issues on the dashboard, and outdated or malfunctioning laptops. The absence of funds to purchase internet bundles for some states directly influenced data quality, due to poor reporting at the LGA-level on a monthly basis, and issues with SIM cards and mobile connectivity affecting health facility reporting. As one informant said, "I think

major challenges affecting Nigeria is number one: internet connectivity for computers…it's a very good project, just needs internet connectivity…" Another said that, "…as a country, we don't have a single laptop, so we relied on CDC or WHO or UNICEF for laptops." Technology successes were reported in some LGAs within Sokoto and Bauchi, where they had functioning laptops and relatively reliable internet connectivity. In respect to vaccine stocks, many LGAs reported issues with broken solar freezers, episodic power supply, and a selective distribution of vaccines and CCE in health facilities. This difference in vaccine stock among certain health facilities was due to individual state governments and their varying capabilities to purchase vaccines for all facilities. Successes with this project component were in facilities with at least one functioning refrigerator, but many still indicated problems with backup generators and thermometers. Vaccine stock-outs and poor vaccine utilization were also observed at the LGA-level, as well as discrepancies between antigens and doses opened or administered during supportive supervision meetings. Statements revealed that no state was successful in having total internet connectivity and proper vaccine stocks for all of its health facilities and LGAs, ultimately not addressing policy/organization constraints as per the second criterion.

Project Component 4: Quality of Data

A consistent component found in the analysis was "quality of data," regarding the accuracy, objectivity, and coverage of data to meet project goals (56). This component was also relevant under the Chee et al. second criteria, where activities can address "policy or organizational constraints;" documents and informants unanimously agreed that previous DHIS projects faced organizational constraints of poor, unevolved data quality policies or tools. Statements largely reflected on the weaknesses of health facilities reporting the vaccine utilization form, and the submissions of blank RI data forms to LGAs. Data falsification was also observed, and data

quality was affected by irregular timeliness and completion of RI data tools within facilities. With the exception of a few, most facilities did not achieve the set target of 80% for timeliness and completeness of reporting. Statements also indicated a need to harmonize the number of reports on the DHIS2 platform with WHO's District Vaccination Data Management Tool (DVD_MT), given the large reporting difference. As one informant called it, "parallel reporting [where] we have immunization data coming in through different reporting templates, which is the DVD_NT and DHIS2 [which] is also a big issue affecting RI data." Poor access to health facilities and LGAs, particularly in the rainy season and in bad terrain, also impeded the flow of RI activities, data collection, and facility reporting to LGAs. However, successes were reported in statements indicating that the project experienced an overall national reduction in wrong data entries and provided more data entry-focused trainings to disseminate knowledge to workers. One informant stated, "There were some indicators not being reported for RI before…vaccine utilization wasn't on the DHIS2 platform before the RI module project started…I think the reporting platform is quite robust now." However, overall state issues in achieve set targets and providing quality and consistent data does not yet address "policy or organizational constraints."

Project Component 5: Sustainability

The fifth component of "sustainability" was defined as project elements that incorporate lasting effects past the duration of the DHIS2 RI project. This component was relevant under the Chee et al. third criteria, where interventions must "produce a permanent systemic impact beyond the term of the project (32)." A majority of document statements indicated that the sustainability components of DHIS2 RI were successful. Specifically, Kano implemented exit strategies that "focused on: capacity development of key officers, strengthen review meetings at the state and LGA level, [and] institutionalize data quality supportive supervision as part of routine

immunization supportive supervision." Nasarawa and some health facilities in Sokoto stated the ongoing institutionalization of project activities into MoH work for after the project end-date, beginning with pairing state staff with existing DHIS2 officers to observe data quality and supportive supervision strategies. One informant agreed with the stated successes from project documents, stating that,

"…I think the project is going to have a long positive impact on the Nigerian health system, because presently…as long as I have connectivity to the internet, access to the internet, I can see what is going on since I am working at the national level…I can see who the accountable and responsible bodies are, and it has made monitoring easy. It also encourages use of data for action [which is] going to be long-lasting."

However, not all states have begun the process of implementing exit strategies and pairing government officers at all levels with DHIS2 RI staff. Other health facilities in Sokoto reported a weakness in M&E officers relying heavily on National Stop Polio Transmission LGA Officers (NSLOs) for data entry. Successes in states strengthened the system by "producing a permanent systemic impact;" other states require more action in institutionalizing project activities.

Project Component 6: Government Ownership

Commitment

The fourth component of "government ownership" focuses on incorporating commitment or responsibility of project activities throughout all levels of government. This component was relevant under the Chee et al. fourth criteria, where ownership requires having clearly "defined rules for country institutions (32)." Nasarawa, Osun, Bauchi, and Abia all reported strong government commitment towards the DHIS2 RI module, expressing political will for its continuation and harmonization of reporting within all health facilities. Statements like "the state

is making effort to increase reporting from private health facilities now," or "the state ministry team was impressed with the findings and promised to intensify monitoring…" expressed government motivation towards fulfilling the objectives of the DHIS2 RI project, and continuing its practices beyond the project time limits. Documents indicated successes in having some state governments fund supportive supervision elements by requesting state-wide officer DQUSS training to improve overall state data quality, and allocating funds for internet data purchases and printed RI data tools. Regular coordination meetings with donor agencies, partner agencies, and tripartite agreements suggested political ownership of project elements at the state level, and key informants agreed that measures were taken to enhance facility ownership among health facility-level, LGA-level, and state-level staff. One key informant said that, "[we speak to them to] try to make them understand that this is their project, this is their data analysis, and not about partners coming through, and they begin to realize that this is a shift…I mean I've been involved in RI activities for years and most of the things that we've done [happened because] partners were leaving…" At the state-level, one informant said that, "so we go to the states, have meetings with policy makers and technical people, so that they can understand the project, what is required from the states in terms of ownership, in terms of financial support, supportive supervision, that should be in place. Then we'll agree on many things…" Statements agreed that advocacy, or solicitation of support for project activities from states, policy-makers, and other government officials, successfully allowed the project to obtain government buy-in. However, Oyo and Sokoto reported a lack of ownership at the LGA-level due to low state funds for data-entry and supervision.

Supportive Supervision

Supportive supervision within the context of DHIS2 RI is the institutionalization of supervision from top-level government health officials all the way to the health facility level (42). Such activities involve mentoring and technical support, assisting with data quality issues, and monitoring reporting rates and dashboard usage. Documents signaled that activities of providing regular feedback from the LGA to the health facility level via evaluations were successfully implemented in many states. Statements indicated that pre-implementation evaluations and feedback were beneficial in tailoring refresher trainings on technical support in LGAs in Kebbi, Sokoto, Taraba, and Bauchi. These states also reported successful implementation of the mentoring of state data mangers and M&E officers, regular monitoring of sessions from the national level, and field mentoring of health facility staff on RI data recording. Low-performing facilities were assigned senior supervisors for mentoring, and refresher courses occurred to ensure strict adherence of data submission. Key informants unanimously declared "supportive supervision" as a successful project activity and critical for the sustainability of the DHSI2 RI module. One said that accountability to supervise was critical, where "we rely on existing structures [to] conduct supportive supervision…technical support should actually continue in the long-term, and monthly review meetings is actually important, it's something we can't do without." Another informant, when asked about project elements that were necessary to continue, stated that, "I think monthly review meetings and supportive supervision, you know, are very key. They need to be long-term because people at [the] lower-level, I mean, when not monitored [or] supervised, naturally they don't tend to do it properly. So there's a need for continuous supportive supervision." Weaknesses in this component were found in those very same states, where LGAs in Taraba, Sokoto, and Enugu reported a weak harmonization of data at the LGA level attributed to the lack of scheduled review meetings, difficulties in scheduling joint

meetings between LIO and M&E officers, and a lack of committees to review implementation checklists. Statements reported that certain supervisors were partial to the issues of their own LGA, and failed to provide enough assistance or solutions to others when required to. Statements complained of these states not recording evidence of when supervision occurs, and that documentation was a common problem where some health facilities would receive feedback on a monthly basis, and others every six months. States reporting commitment within their governments are successes for the project, but without having enforced activities like supportive supervision within all facilities and LGAs in a state, the project component does not yet strengthen the system by "tailoring to country-level constraints" that should have "clearly defined roles."

Project Component 7: Financial Resources

Funding was stated as a consistent weakness throughout documents and interviews, where limited funds for RI activities and data entry were allocated at the state-level, along with limited funds for health worker salaries and vaccine distribution. This project component was relevant under the fourth Chee et al. criterion, where financial constraints were "country-specific constraints (32)," given that Nigeria's classification as a LMIC. Some states received more donor support than others, reflected in an informant comment stating that "…some states are having challenges of driving this program [given the] issues with technical support, providing their own funding, issues with donors…" Another informant reported that "the project plan is different because initially there [were] some sources of funding going…however, funding is now slow…so we're trying to see how to get funding if possible for all of these states to carry out [activities]." Given that states each financed the DHIS2 RI project in different ways, some chose to fund supportive supervision and training activities, purchase vaccine supplies, and CCE when

others did not. However, successful financing structures for some activities did exist in Enugu and Sokoto, where their state governments took on responsibilities for funding the printing of RI data tools and monthly joint M&E/LIO RI data review meetings. Health facilities in Sokoto, Kano, Taraba, and Bauchi institutionalized quarterly joint meetings, updated micro-plans in most LGA and health facilities, and facilitated procurement of NHMIS data tools for the state. However, not all health facilities or LGAs in these states received full funding for ownership activities, data reporting activities, vaccines, CCE, and more, not yet meeting "country-specific constraints."

DISCUSSION

Chee et al. notes a widespread lack of understanding of health systems strengthening activities among global health program implementers. Without differentiating between activities that support or strengthen country health systems, the Chee et al. framework claims that donors may become unsatisfied with the results, reducing the incentive to fund similar programs in the future (32). The framework further claims that supportive projects may induce negative externalities of disrupting the development of a country health system, and even worsening current dysfunctions. In reviewing the DHIS2 RI project in Nigeria, which intended "to strengthen RI data collection, reporting, and accountability systems leading to the availability and use of timely, accurate and high quality routine immunization data for effective decision-making in Nigeria (42)," this study aimed to modify the Chee et al. framework. Instead of singularly prescribing interventions that meet the four criteria to have "strengthened" or "supported" a health system, this analysis incorporated a modified framework that observes the strengths or weaknesses of each project component to determine what strengthened, supported, or simultaneously strengthened and supported the Nigerian health system. Supportive activities, using our framework, can be

beneficial and often times essential for projects to enact. Understanding that there are complexities within project components that either help or weaken a project's ability to strengthen a system, this analysis brought seven major components of the DHSI2 RI project to light and analyzed their strengths and weaknesses as it relates to its corresponding Chee et al. criterion.

First Criterion

The component of "coordination" involved successes that reported the project's ability to harmonize existing data quality tools from other health interventions to avoid duplication. Partner agencies involved with the project increased buy-in with other health information projects in the country. Health workers trained in the DHIS2 RI project were also involved at the state, LGA, or health facility-level with other health projects; documents and interviews indicated that project efforts to train in proper and timely data entry were similarly beneficial in other health efforts. This successfully answers the first criterion's question of whether the project incorporates "cross-cutting benefits beyond a single disease," indicating that "coordination" was a strengthening project component for those states. With tools like data entry and supportive supervision that are applicable to other existing health information systems, the DHIS2 RI project can prevent efforts of other existing or future health projects from duplicating such tools and policies. However, weaknesses were apparent in some states where RI activities conflicted with one another, and data entry was poor. Additionally, officers from the Nigerian polio response team were deployed into states to provide technical expertise on the RI dashboard. This supportive "short-term gain" of having experienced officers temporarily assist health workers is beneficial in projects saving financial resources and time on training technical staff members, and for health workers to learn from such experienced staff. This supportive activity of

temporarily deploying workers is still critical for obtaining quick data reporting results in a short project timeframe, and could be necessary for long-term gains. Implementers should address whether such supportive activities can be financially sustained after the project-end date, by either keeping experienced workers from leaving, or providing exit-strategies to incorporate training new health workers.

Second Criterion

The health workforce was also a component that included both successes and weaknesses. The institutionalized trainings were successful in states that implemented them, but Bauchi and Sokoto had missed refresher trainings, poor quality of sessions, and observable knowledge gaps in health workers on critical project elements. States, both with or without implemented trainings, reported poor attitudes, knowledge gaps, and low retention rates. Moreover, nonpayment of salaries was a considerable weakness in many states that also contributed to low motivation and dropouts. This decrease in the numbers of the health workforce in some states weakens the project's ability to strengthen the HIS. While institutionalized trainings were largely successful, weaknesses of knowledge gaps, poor quality of trainings, and nonpayment of salaries within those states deter efforts to integrate the building blocks of the health workforce with the HIS.

Technology and vaccine stock indicated weaknesses in ensuring internet connectivity, functional laptops, and varying vaccine supplies and CCE among facilities. Given that this component is to address "policy or organizational constraints," the DHIS2 RI project reported that a number of states still experienced such constraints with poor internet coverage, poor or no CCE, and few or no vaccines in facilities, all influencing data quality. Some positive attributes were reported; few states stated that internet was working and they had at least one functional CCE in their facility.

However, a lack of consistent technology and vaccine stock within a state indicates that state policies or organizational constraints require more attention. A supportive element that possibly provided essential short-term technology gains was the provision of laptops by CDC to each LGA. Though this activity was not long-lasting and the laptops have a lifespan of a few years, this was critical in addressing immediate constraints of no technology in some states for data entry. When providing web-based modules in resource-poor states, implementers should account for contextual constraints that make project activities difficult to continue independently over the long-term.

Data quality also aimed to address "policy or organizational constraints" of poor reporting and data quality tools and policies. States did not reach the target of 80% of health facilities reporting timely and complete RI data. Multiple and conflicting data tools were still used in some states, as was old health facility reports. Health workers in some states were over-reporting, miscalculating, and repeating data. While overall national RI data reporting improved, implementers should observe ways to enforce state-level policies that provide consistent data quality tools and trainings. Through successful data reporting activities within and across all states can this component meet the requirements of addressing "policy or organization constraints" for strengthening the HIS.

Third Criterion

The component of sustainability had statements on successes within Kano, Nasarawa, and health facilities in Sokoto. Such states implemented exit-strategies and planning for ongoing institutionalization of activities after the project end-date, providing for a more strengthened HIS in those states for addressing the continuation of activities in the long-term. It is critical for implementers to understand that such states prioritizing sustainability in activities can also

include supportive activities. For instance, Nasarawa was lauded for institutionalizing RI activities, but was also one of the states where officers supported the system by deploying polio-response technical assistants. Both activities that strengthen and support part of a health system can and do occur simultaneously, and are often times critical for achieving project goals.

Fourth Criterion

Government ownership activities were successful in many states advocating to SMOHs and partner agencies to provide political will and financial resources for facilities. In these states, government motivation paid for activities like supportive supervision or vaccines, which helped to strengthen the system by incorporating clearly "defined rules for country institutions." However, some states that reported government commitment also reported a lack of enforcement of supportive supervision activities within all facilities and LGAs in a state, indicating a failure in "defined rules" to hold government accountable. Additionally, within states there were some health facilities, but not all, with funds for existing CCE and storage areas. Expanding activities like government ownership within resource-poor areas requires implementers to first tackle constraints of individual state funding capabilities for project components.

Study Strengths and Weaknesses

This study's strengths are the amount of information available on DHIS2 RI project contents, the continuous monitoring of project strengths and weaknesses, updates, listening to health worker concerns, stakeholder meetings, and more. The range of viewpoints from key players in the project was reflected in the documents that gave a more nuanced and impartial perspective than the document review alone. Informants also provided in-depth information that supplemented/clarified the knowledge gained from documents. Another strength was the use of

established criteria of elements that distinguished “health systems strengthening” concepts. The same criteria have been used to analyze a multitude of global health organization interventions, including a Global Alliance for Vaccines and Immunization (GAVI)-directed evaluation of its systems strengthening funding that discovered country funds being used towards “immediate support to deliver immunization and maternal and child health services” (32).

One major weakness of this study was a likely reporting bias from the reviewed project documents. While every document included strengths and weaknesses, there may have been a tendency to report negative findings more frequently than the positive effects of the DHIS2 RI project. Lastly, there was a lack of inter-rater reliability within the study, given that only the PI conducted the entirety of the analysis.

CONCLUSIONS

Health systems strengthening interventions are useful programmatic tools used to achieve broad health outcomes by improving health services and structures beyond the time limits of an intervention. Health systems support interventions are valuable for short-term advances that contribute to interventions requiring immediate additions to an existing health system. The Chee et al. 2013 framework argues that interventions must fulfill four set criteria to be labelled as “strengthening,” and a failure to meet set criteria makes the intervention or activity “supportive.” This study contests such a framework by suggesting that non-strengthening activities, or what Chee et al call supportive activities, can still strengthen a system to eventually reach long-term gains. Chee et al. makes the argument that funders of such interventions intending to strengthen a system may become displeased with results and unwilling to invest in similar projects if activities were in reality supporting a system. This study claims that often times in low resource-area settings, interventions must incorporate both strengthening and supportive aspects of the

health system for long-term success. The thematic analysis of the DHSI2 RI project showed that each of the seven components contained some supportive, strengthened, or supportive and strengthened elements, and calls for CDC/BMGF to address the weaknesses in each component before the project end-date. Additionally, this analysis seeks for CDC/BMGF to ensure that supportive activities are still institutionalized within each state for long-term use. Public health implementers and investors must understand that both systems strengthening and systems support approaches are critical for improving health outcomes; however, fully understanding that implementing both simultaneously may ultimately reach quicker and long-lasting success within the health system could be revolutionary.

CHAPTER 4: PUBLIC HEALTH IMPLICATIONS AND RECOMMENDATIONS

This qualitative analysis of the DHIS2 RI project suggests a number of recommendations and public health implications for the CDC Global Immunization Division and BMGF in addressing systems strengthening concerns. By acknowledging that components could have both strengthening and supportive elements, this framework provides a new way for implementers to assess project successes and weaknesses for identifying areas that require further attention. This project aims to influence future DHIS2 RI interventions both before the project end-date and in other country contexts by addressing reoccurring issues in strengthening the HIS.

This study poses a number of public health implications for implementers and donors who invest in health system strengthening programs. Systems strengthening is critical for an intervention to ensure that a country's health structure can tackle future health threats. However, this study indicates that supportive activities temporarily assisting in reaching project objectives may be critical for ensuring long-term health systems gains. This combination of both strengthening and supportive elements shows that while the Chee et al. criteria is expansive, it does not fit all country contexts; having both activities are often necessary in resource-poor areas where the only way to achieve long-term benefits are to implement short-term ones. With proper measurement of the effectiveness of all activities, similar HIS projects can monitor its current progress in light of this study's developed framework.

This study proposes the following recommendations for CDC and BMGF in addressing DHIS2 RI weaknesses:

1. **Improve health worker knowledge of data quality tactics through screenings, workshops, and assessments.**

- Merging advocacy efforts with training efforts to ensure statewide policies on enforced and regular trainings at the state, LGA, and health-facility level,
- Reviewing all state, LGA, and health-facility level trainings to ensure that standard information on proper data quality and basic routine immunization knowledge is being given,
- Providing a pre/post-test evaluation for workers and trainers to understand knowledge gaps for improvement in future trainings, and incorporating a baseline percentage of correct answers that workers must attain before beginning data collection and entry,
- And assessing health worker motivation and aptitude when recruiting to evaluate their motivation towards fulfilling strict data quality protocol, current knowledge on laptops/computer use, and a willingness to improve statewide and national RI data reporting.

2. **Address health worker attitudes and low retention rates by assuring fixed salaries and professional development incentives for proper data entry and reporting.**

- Advocating to states that do not have fixed payments for their health workers to establish a set schedule for when fixed payments will occur for all health workers,
- Advocating to states to establish professional development incentives across the health facility and LGA-levels to allow for career mobilization and improved worker attitudes,
- Addressing the states that are financially incapable of consistently providing salaries/vaccines/CCEE by formulating financial schemes (seeking donor funds), while simultaneously creating strategies for long-term financial structures (reprioritizing income tax revenue),
- And encouraging donor or stakeholder buy-in by presenting evidence-based data from all levels on the improvement of RI data reporting since project initialization, in order to convince participation.

3. **Increase the health workforce by seeking experienced technical staff for all LGAs.**

- Hiring more practiced staff in technical matters to mitigate the overburdening of work that health workers experience at the health facility and LGA-level,
- Involving existing health workers with the training process of technical staff, as well as in refresher trainings for deployed staff from the polio-response team, so that more workers understand the platform functionalities in case of drop-outs,
- Building communication among all LGA technical staff within a state to form a community of support that addresses common technological issues,
- And having national governments encourage or incentivize internet companies to work with current markets in all implemented states for supporting a new age of better quality data and affordable internet access over a long-term period.

4. **Ensure that RI activities are not conflicting within states.**

- Re-evaluating all RI activities occurring within states at the state government-level to reduce duplication of similar efforts,
- And forming health facility and LGA connections within states that integrate DHIS2 RI trainings and data entry trainings for other health projects for improving data quality on a national-level.

Public Health Implications

This study poses a number of policy implications for CDC/BMGF in improving weaknesses before the DHIS2 RI project-end date, as well as improving similar HIS projects in contexts like Nigeria. When designing a health intervention or project, a theory of change is created, or "an approach which describes how a programme brings about specific long-term outcomes through a logical sequence of intermediate outcomes" (43). By conducting a process that outlines the short and intermediate goals for long-term change, project implementers can establish the logical

arrangement of steps that induce lasting change in health outcomes. In the case of the DHIS2 RI dashboard project, short-term gains like the provision of laptops and deployed staff from other health project areas were still critical in ensuring continuation of other project activities. So long as the theory of change involves transitioning supportive activities to those that are financed and supervised after the project end-date, an integrated intervention of supportive and strengthened features can be beneficial and even critical for lasting change.

This study also brings to light that similar public health interventions must involve proper measurement of activities. Monitoring project functions to understand activity strengths and weaknesses in relation to an overall goal of strengthening a system requires consistent activity updates. By encouraging implementers to closely supervise activity successes and weaknesses, and to incorporate a framework that understands the benefits of both strengthening and supportive project components, this study hopes to revolutionize how systems strengthening theory of change translates to project functions within low-resource areas.

APPENDIX

Appendix 1: Key Informant Interview Guide

Project Title: Health system strengthening or health system support? A qualitative case study application of the Chee et al framework to the DHIS2 project in Nigeria

Key Informant Questionnaire

Verbal Informed Consent in separate document.

Participation

1. **What is your role in the DHIS2 RI module project in Nigeria?**
2. **What type of activities or responsibilities does your role entail?**

System Impact

3. **In your opinion, does the DHIS2 project in Nigeria have benefits beyond routine immunization?**
    a. *Follow-up prompt:* For example, how might data entry or data use of other health areas (such as HIV, family planning, antenatal care, tuberculosis, malaria) in DHIS2 be affected by the project?
4. **Before the DHIS2 project, what were some constraints or issues in reporting routine immunization data?**
    a. **In your opinion, how has the project addressed these constraints or issues?**
        i. *Follow-up prompt:* For example, addressing policy constraints might include: national standards for DHIS2 reporting, clear documentation of roles and responsibilities, adequate resources to implement the national health information system strategic plan/policies, etc. Addressing organizational constraints might include: adequate number and trained personnel at national/state/local levels to implement module (including technical support and troubleshooting, training, data validation and review), adequate equipment and supplies (including copies of paper forms) on site, appropriate guidance and reference materials, accountability, management, and supportive supervision processes, etc.

Sustainability

5. **Are there any project roles that you might continue to engage in past the project end-date?**
6. **This project involves State and LGA-level training, provision of equipment such as laptops and paper tools, monthly review meetings, supportive supervision, and technical support for the DHIS2 platform. Are there other parts of this project that you would like to mention?**
    a. **Which of these elements of the DHIS2project should continue long-term (after the end of external donor support)?**

7. **What changes, if any, might need to take place in policy, systems, attitudes, behaviors, or budgets to see a permanent systemic impact of the project in Nigerian health information systems?**

Stakeholder Roles

8. **In your opinion, what roles has the DHIS2 project defined for:**
   a. **National-level stakeholders?**
   b. **State-level stakeholders?**
   c. **LGA-level stakeholders?**
   d. **Health facility stakeholders?**
   e. **External partners?**
9. **How have these roles been tailored to the conditions in Nigeria?**

Conclusion/Other Comments

10. **Are there any other comments that you would like to make regarding the long-term impact of the DHIS2 project on the Nigerian health system?**

REFERENCES

1. MacMillan, M. (2009). Rebuilding the world after the second world war from https://www.theguardian.com/world/2009/sep/11/second-world-war-rebuilding
2. International Health, C. (2002). Constitution of the World Health Organization. 1946. *Bull World Health Organ, 80*(12), 983-984.
3. McCarthy, M. (2002). A brief history of the World Health Organization. *Lancet, 360*(9340), 1111-1112. doi:10.1016/S0140-6736(02)11244-X
4. Litsios, S. (2015). Re-imagining the control of malaria in tropical Africa during the early years of the World Health Organization. *Malar J, 14*, 178. doi:10.1186/s12936-015-0700-9
5. Brown, T. M., Cueto, M., & Fee, E. (2006). The World Health Organization and the transition from "international" to "global" public health. *Am J Public Health, 96*(1), 62-72. doi:10.2105/AJPH.2004.050831
6. Alonso, P. L., Brown, G., Arevalo-Herrera, M., Binka, F., Chitnis, C., Collins, F., . . . Tanner, M. (2011). A research agenda to underpin malaria eradication. *PLoS Med, 8*(1), e1000406. doi:10.1371/journal.pmed.1000406
7. WHO. *Expert Committee on Environmental Sanitation,* Third Report. Geneva: World Health Organization, Technical Report Series, No, 77; 1953.
8. Levine, R. (2004). *Millions Saved: Proven Successes in Global Health*: Center for Global Development.
9. Henderson, D. A. (1987). Principles and lessons from the smallpox eradication programme. *Bull World Health Organ, 65*(4), 535-546.
10. Msuya, J. (2004). Horizontal and Vertical Delivery of Health Services: What Are The Trade Offs? *Making Services Work for Poor People: World Development Report 2004/5*: The World Bank.
11. Raviglione, M. C., & Pio, A. (2002). Evolution of WHO policies for tuberculosis control, 1948-2001. *Lancet, 359*(9308), 775-780.
12. Cueto, M. (2004). The origins of primary health care and selective primary health care. *Am J Public Health, 94*(11), 1864-1874.
13. Olmen, J. v., Marchal, Bruno, Damme, Wim Van, Kegels, Guy, Hill, Peter S. (2012). Health systems frameworks in their political context: framing divergent agendas. *BMC Public Health, 12*(774).
14. Ruger, J. P. (2005). The changing role of the World Bank in global health. *Am J Public Health, 95*(1), 60-70. doi: 10.2105/AJPH.2004.042002
15. Ollila, E., & Koivusalo, M. (2002). The World Health Report 2000: World Health Organization health policy steering off course-changed values, poor evidence, and lack of accountability. *Int J Health Serv, 32*(3), 503-514.
16. Blendon, R. J., Kim, M., & Benson, J. M. (2001). The public versus the World Health Organization on health system performance. *Health Aff (Millwood), 20*(3), 10-20.
17. Reich, M. R., & Takemi, K. (2009). G8 and strengthening of health systems: follow-up to the Toyako summit. *Lancet, 373*(9662), 508-515. doi: 10.1016/S0140-6736(08)61899-1
18. Barredo, L., Agyepong, I., Liu, G., Reddy, S.. (2014). Goal 3—The SDGs and a Healthier 2030. *UN Chronicle, 51*(4).
19. Progress towards the Sustainable Development Goals: Progress of Goal 3 (2016) *Report of the Secretary-General*. Geneva, Switzerland: United Nations Economic and Social Council

20. World Health Organization. (2007). *Everybody's business -- strengthening health systems to improve health outcomes : WHO's framework for action*. Geneva: World Health Organization.
21. Ollila, E., & Koivusalo, M. (2002). The World Health Report 2000: World Health Organization health policy steering off course-changed values, poor evidence, and lack of accountability. *Int J Health Serv, 32*(3), 503-514.
22. World Health Organization. Dept. of Human Resources for Health. *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies (in press)*. Geneva: World Health Organization.
23. World Health Organization. (2006). *The world health report : 2006 : working together for health*. Geneva: World Health Organization.
24. Resolution WHA67.24. Follow-up of the Recife Political Declaration on Human Resources for Health: renewed commitments towards universal health coverage. In: Sixtyseventh World Health Assembly, Geneva, 19–24 May 2014. Resolutions and decisions, annexes. Geneva: World Health Organization; 2014 (WHA67/2014/REC/1; (http://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_R24-en.pdf?ua=1, accessed 5 June 2015).
25. Global strategy on human resources for health: Workforce 2030. (2016). Geneva, Switzerland: World Health Organization
26. Siddiqi, S., Masud, T. I., Nishtar, S., Peters, D. H., Sabri, B., Bile, K. M., & Jama, M. A. (2009). Framework for assessing governance of the health system in developing countries: gateway to good governance. *Health Policy, 90*(1), 13-25. doi: 10.1016/j.healthpol.2008.08.005
27. WHO Statistical Information System (WHOSIS). (2016). from http://www.who.int/whosis/en/
28. World Health Organization. (2010). *The world health report: health systems financing: the path to universal coverage: executive summary*. Geneva: World Health Organization.
29. Xu, K., Evans, D. B., Carrin, G., Aguilar-Rivera, A. M., Musgrove, P., & Evans, T. (2007). Protecting households from catastrophic health spending. *Health Aff (Millwood), 26*(4), 972-983. doi: 10.1377/hlthaff.26.4.972
30. Bigdeli, M., Peters, D., Wagner, A. (2014). Medicines in Health Systems: Advancing Access, Affordability and Appropriate Use. Geneva, Switzerland: World Health Organization Q.
31. Toolkit on Monitoring Health Systems Strengthening: Health Informtion Systems. (2008). Geneva, Switzerland: World Health Organization
32. Chee, G., Pielemeier, N., Lion, A., & Connor, C. (2013). Why differentiating between health system support and health system strengthening is needed. *Int J Health Plann Manage, 28*(1), 85-94. doi: 10.1002/hpm.2122
33. Savigny, D. d., Adam, T., Alliance for Health Policy and Systems Research., & World Health Organization. (2009). *Systems thinking for health systems strengthening*. Geneva: World Health Organization.
34. Lippeveld T. Routine health information systems: the glue of a unified health system. Keynote address at the Workshop on Issues and Innovation in Routine Health Information in Developing Countries, Potomac, March 14-16. Washington, DC: JSI; 2001.
35. AbouZahr, C., & Boerma, T. (2005). Health information systems: the foundations of public health. *Bull World Health Organ, 83*(8), 578-583. doi: /S0042-96862005000800010

36. Strengthening Routine Immunization from http://www.who.int/immunization/diseases/poliomyelitis/endgame_objective2/routine_immunization/en/
37. Smith, P. (2015). Some reflections on priorities for health systems strengthening in the WHO European Region. Copenhagen, Denmark: WHO Regional Office for Europe.
38. Burton et al. WHO and UNICEF estimates of national infant immunization coverage: methods and processes. B World Health Organ. 2009; 87:485–564.
39. Wallace, A. S., Ryman, T. K., & Dietz, V. (2014). Overview of global, regional, and national routine vaccination coverage trends and growth patterns from 1980 to 2009: implications for vaccine-preventable disease eradication and elimination initiatives. *J Infect Dis, 210 Suppl 1*, S514-522. doi: 10.1093/infdis/jiu108
40. Duclos, P., Okwo-Bele, J. M., Gacic-Dobo, M., & Cherian, T. (2009). Global immunization: status, progress, challenges and future. *BMC Int Health Hum Rights, 9 Suppl 1*, S2. doi: 10.1186/1472-698X-9-S1-S2
41. Hinman, A. R., David. (2010). Immunization Registries Can Be Building Blocks For National Health Information Systems. *Health Aff (Millwood), 29*(4), 676-682. doi: 10.1377/hlthaff.2007.0594
42. C.D.C (U.S) (2016). Implementation of the District Health Information System Routine Immunization Module in Nigeria: A Progress Report.
43. Breuer, E. L., Lucy; De Silva, Mary; Lund, Crick. (2016). Using theory of change to design and evaluate public health interventions: a systematic review. *Implementation Science, 11*(63). doi: 10.1186/s13012-016-0422-6
44. National Foundation for the Centers for Disease Control and Prevention, I. (2017). Scale up of the Routine Immunization Dashboard on the District Health Information System and Strengthening the Nigeria Health Management Information System. Nigeria: Bill and Melinda Gates Foundation.
45. USAID's Vision for Health Systems Strengthening. (2015). Washington, D.C.: USAID.
46. Uilici, S., Smith, R., & Signorelli, C. (2015). Role of vaccination in economic growth. *J Mark Access Health Policy, 3*. doi: 10.3402/jmahp.v3.27044
47. Na ´jera JA, Gonza ´lez-Silva M, Alonso PL (2011) Some Lessons for the Future from the Global Malaria Eradication Programme (1955–1969). PLoS Med 8(1): e1000412. doi:10.1371/journal.pmed.1000412
48. WHO (1955) Eighth World Health Assembly (Mexico, D.F., 10–27 May 1955). Official records of the World Health Organization, Nu 63. Geneva: World Health Organization. pp 236–240.
49. WHO (1957) Expert Committee on malaria, sixth report, WHO Technical Report Series, number 123. Geneva: WHO. 4 p.
50. Fenner, F., Henderson, D. A., Arita, I., Jezek, Z., Ladnyi, I. D., & World Health Organization. (1988). *Smallpox and its eradication*. Geneva: World Health Organization.
51. Layton, B. D. B. (1966). The 19th World Health Assembly, May 1966. *Canadian Medical Association Journal, 95*(3), 131–132.
52. Okwo-Bele, J. M., & Cherian, T. (2011). The expanded programme on immunization: a lasting legacy of smallpox eradication. *Vaccine, 29 Suppl 4*, D74-79. doi: 10.1016/j.vaccine.2012.01.080

53. Kohler, et al. (2016). Health Systems Support and Health systems Strengthening: two key facilitators to the implementation of ambulatory tuberculosis treatment in Uzbekistan *Health Economics Review, 6*(28). doi: 10.1186/s13561-016-0100-z
54. Health Systems Strengthening (HSS). (2009). from https://2009-2017.pepfar.gov/about/strategy/ghi/134854.htm