

Developing A Central Analytic Repository To Improve Decision Making By Stakeholders

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Abstract

Background

The rise in data analytics has resulted in the need for data to be pooled into centralized large-scale repositories to support more organized analytics. In the health sector, housing health data in a central analytic repository makes it easier for policymakers to access and make faster, more efficient informed decisions that impact the population, especially in cases of emergencies and disease outbreaks. Our study aimed to develop a centralized health data analytics repository for Nigeria called the Multi-Source Data Analytics and Triangulation (MSDAT) platform to improve decision-making by stakeholders.

Methods

The MSDAT design and development was a data and user-centred process guided and informed by the perspectives and requirements of analysts and stakeholders from the Federal Ministry of Health, Nigeria. The inclusion of health indicators and data sources on the platform was based on: (1) national relevance (2) global health interest (3) availability of datasets and (4) specific requests from stakeholders. The first version of the platform was developed and iteratively revised based on stakeholder feedback.

Results

We developed the MSDAT for the purpose of consolidating health-related data from various data sources. It has 4 interactive sections for; (1) indicator comparison across routine and non-routine data sources (2) indicator comparison across states and local government areas (3) geopolitical zonal analysis of indicators (4) multi-indicator comparisons across states.

Conclusion

The MSDAT is a revolutionary platform essential to the improvement of health data quality. By transparently visualizing data and trends across multiple sources, data quality and use are brought to focus to reduce variations between different data sources over time and improve the overall understanding of key trends and progress within the health sector. Hence, the platform should be fully adopted and utilized at all levels of governance. It should also be expanded to accommodate other data sources and indicators that cut across all health system areas.

Background

The implementation of effective health policies requires the use of data that has been analyzed, simplified and contextualized. Therefore, creating a central space for health data analytics is an approach that can facilitate quick access to the right information to shape policy decisions (Lavis *et al.*, 2004). A considerable gap exists between health data and the formulation and implementation of health policies particularly in low and middle-income countries (LMICs). Although research already plays its role in the area of policymaking, informed national health policies can be improved through an emphasis on

healthcare analytics. Furthermore, the complex nature of decision-making requires inputs from a broad analytic base which transcends basic data analysis and includes analytical knowledge generated from local evidence and good practices.

In recent years, there has been an exponential increase in data which has led to a considerable rise in data analytics. This has resulted in calls from experts to ensure that this data is pooled into a centralized large-scale repository to support more organized analytics (Prainsack & Buyx, 2013; Steinsbekk *et al.*, 2013). A data repository is a huge database infrastructure which gathers, stores and manages varying data sets for analysis, distribution and reporting (Naeem, 2020). Having a central analytic repository has numerous benefits including being able to store, manage, access and manipulate stored data at any point in time. In the health sector, policymakers stand a lot to gain from having access to a central analytic repository as health data/information is made available at their fingertips, thereby allowing them to extract insights and make informed decisions to shape health policies at various administrative levels.

The Role of Central Analytic Repositories in analytics and decision making

A central analytic repository (CAR) is a collection of stored data from existing databases integrated into one so that they can be easily accessed. A CAR can be likened to a conventional library but in this case, physical space is not required. It is essentially created by integrating the data from all available sources thus making it easy to organize, secure and analyze the data (Ma, 2019). Health data in a CAR makes it easier for policymakers to access the data and make informed decisions that will impact the health sector. Decisions can also be made faster and more efficiently, especially in cases of emergencies and disease outbreaks.

Benefits of a centralized analytic repository in the health sector

1. Enhances policy decisions: A CAR can determine the performance of an entire healthcare delivery system, due to the fact that policymakers can have access to comprehensive, accurate, and better-organized data. By making data from various sources available in one location, policymakers can make data-backed decisions.
2. Centralized storage and maintenance of data integrity: Data integration through a central analytic repository allows for users to make changes to the data, and these changes are reflected in real-time throughout the healthcare system. Data integrity is maximised as the whole database is stored at a single location. This means that it is easier to coordinate the data and ensure good data quality in terms of data accuracy and consistency.
3. Increases data quality and accuracy: A central repository offers trustworthy data in order to produce accurate trend analysis due to the data being consistently updated and standardised from a central database.
4. Data triangulation: Data triangulation can provide insights into multi-systemic issues in the health space. A centralised analytic repository facilitates the availability of data for cross-programmatic comparisons and triangulation.

5. Big data analytics and machine learning: The use of central repositories can help generate analysis and insights from big data and create machine learning models to predict outcomes based on already existing data points.
6. Reduces redundancies and saves time: The elimination of obsolete information reduces the time needed to review and make decisions leading to an increase in productivity. This enhanced collaboration throughout the health sector ultimately saves decision-makers time.
7. Maintains a comprehensive data history and security: Since all the data is in one place, there can be stronger security measures around it. So, the centralised database is much more secure.

Disadvantages

1. Since all the data is at one location, it takes more time to search and access it. If there is a challenge with internet connectivity, this process takes even more time.
2. There may be a lot of data access traffic for a centralised database. Increased traffic may cause database performance issues. The database may require periodic expansions in its capacity to handle multiple requests.
3. Since all the data is at the same location, if multiple users try to access it simultaneously it creates a problem. This may reduce the efficiency of the system.
4. Without a database recovery measure in place, a system failure will most likely result in the destruction of all data in the database.

Decision-making in the Nigerian health sector: The data accessibility problem

Although there is a lack of evidence to adequately describe the extent of inaccessibility to comprehensive health data, it remains a limitation for Nigeria's policy implementation and health sector growth. Poor knowledge of data demand and use for health planning and resource allocation is another limiting factor. Data replaces assumptions and allows researchers, clinicians and policymakers to provide informed decisions based on real case studies. In situations where there are multiple data sources for population health metrics, storing and comparing health data from these different sources provides a comprehensive view of the health status of the populace.

Innovations to improve data accessibility: The Centralised Data Repository

Few innovations exist to address issues of health data accessibility in Nigeria. Most platforms in existence were designed at a global level to provide information related to clinical programmes and services (Uneke *et al.*, 2019). These kinds of resources include; the Health Systems Evidence repository, the Health Technology Assessment Database, the Evidence to Policy Network (EVIPNet), the Virtual Health Library, and the Physician Data Query (PDQ)-Evidence repository. However, in Nigeria, there had never been a resource built for the purpose of aggregating all health-related data, until the development of the Multi-Source Data Analytic and Triangulation (MSDAT) platform.

The MSDAT platform was built by Nigeria's Federal Ministry of Health (FMoH) as a solution to the challenge of data availability and accessibility among health agencies and stakeholders in the country. The MSDAT platform provides a single transparent view of key health indicators from multiple data sources. Recognizing that data quality, trends and interpretation depend on the data source and methodology, the platform offers comparisons of key metrics across three categories of data sources, namely; routine, surveys, and global estimates.

Methodology: Building A Centralised Health Data Analytics Repository For Nigeria

Conception

The eHealth for Everyone Foundation (E4E) team and the Department of Health Planning, Research and Statistics (DHPRS) had collaboratively highlighted some issues that severely hamper the use of data in the country, they include;

1. Limited time, effort and skill to conduct data analysis
2. Poor accessibility and visibility of health data
3. Insufficient quality information
4. Low trust in routinely collected data
5. No comprehensive analysis of the available health data sets and no comprehensive integrated platform to facilitate such analysis

With the presence of these issues, the existence of multiple data sources and little trust in the routinely collected data on the National Health Management Information System (NHMIS), the FMoH recognized the need to have a tool to mitigate these gaps and meet these data analytics needs.

To this end, the MSDAT was conceptualised to provide data on key indicators and enable comparisons against various data sources. In the conception phase, several requirements were documented, for example;

- a. Comparison of indicators across routine and non-routine data sources.
- b. Comparison of indicators across states and local government areas (LGAs)
- c. Geopolitical zonal analysis of indicators
- d. Multi-indicator comparisons across states

Design and Development

Based on the stated requirements, several mockups were developed to facilitate reviews and adequately meet stakeholder (DHPRS) needs. The design phase took a very pragmatic approach to ensure that the

platform is simple to use and easy to understand. Our approach was guided by the 9 principles of digital development (Principles for digital development, 2017).

1. Principle 1: Designing with the users

In designing the mockups, we developed personas of the primary users of the platform, to understand their skills, limitations and preferences. This was achieved through conversations, observations and feedback from the users.

2. Principle 2: Understanding the existing ecosystem

This principle helped us to understand the use cases and application of the platform as a national tool for health data analytics. With a full understanding of the key players and users, we were able to navigate the best design and implementation strategies to establish ownership of the platform. Knowledge of the Nigerian health information system, major players in the health sector and the challenges of the health sector as regards data use, guided the design of the platform.

3. Principle 3: Design for scale

The system architecture was developed using a framework that allows for scalability. With a flexible system architecture, the platform is able to accommodate more data sources and indicators across different health system areas. Designing flexible data systems also allows for adaptability to new use cases.

4. Principle 4: Built for sustainability

The success of any project implementation depends on its adaptability and ownership. With this in mind, we designed the platform to be self-teaching through tutorials and tour guides accessible on the platform. This was in addition to the development of training materials for primary users at the FMOH and partner agencies.

5. Principle 5: Be data-driven

The availability of quality data was a driving force behind the design and implementation of the MSDAT platform. The design was optimised to simplify the presentation of analysed data with applicable disaggregations.

6. Principle 6: Open standards, open data, open-source and open innovation

The E4E team designed the MSDAT platform using open standards and innovative approaches. The platform encourages the use of data that is not readily available on an open web page, by providing a single transparent view of key health indicators from several data sources.

7. Principle 7: Reuse and improve

All feedback from stakeholders and partners was documented and taken into consideration to improve the platform development. To improve on any form of expansion, the MSDAT was developed in several modules that can be easily modified when a need for expansion arises. As new challenges arise in the deployment and design of the MSDAT platform, provisions were made for adjustment and modifications as the case may be.

8. Principle 8: Addressing privacy and security

At the time of the initial development, the platform did not make use of personal data and did not breach any security measures.

9. Principle 9: Ensuring collaborative efforts

To encourage the use and ownership of the platform, several stakeholder meetings and workshops were organised to demonstrate the use and application of the platform. This further strengthened the transparency of the platform and encouraged partnerships and intersectoral collaboration. The MSDAT platform was designed for both public and private agencies interested in the Nigerian health system to utilise.

MSDAT System Architecture

The system architecture of the MSDAT platform is made up of 7 major components (diagrammatically represented in the image below), namely:

1. MSDAT Web platform: This component enables users to interact with available datasets through intuitive visualisations and allows them to download and share data.
2. MSDAT Application Programming Interface (API): The MSDAT API component is the link between the platform and the database where all data is stored. It manages the relationships between functionalities on the platform and fetches data for the visualisations.
3. Indicator Database: This component stores and manages the indicator metadata within a relational database and interacts with the MSDAT Data Management Interface.
4. MSDAT Data Management Interface (DMI): The DMI is a relational database management system that manages the data for the platform and other components. With the DMI, authorised users can create, upload, delete, review and extract data.
5. MSDAT mobile application: The MSDAT mobile application enables users to access the dashboard data and visualisations via mobile devices (phones, tablets, etc).
6. Artificial Intelligence (AI) and Natural Language Processing (NLP): With the AI and NLP component, for example, users can make use of search terms and the system would intelligently return results of applicable indicators of interest to the user.

External API engine: This component allows the platform to interact with other databases (data sources) via their APIs. This engine also transforms the external data into the data structure that the MSDAT DMI can consume for the dashboard visualisations.

Engagement with M&E staff, Stakeholders and other partners

To facilitate the development of the platform, design mockups were developed and shared with the DHPRS-M&E team to be reviewed. Based on the mock-up designs and implementations carried out after the review, the first version of the MSDAT dashboard was developed. With the involvement of all stakeholders and partners in the developmental phase, all suggestions were taken on board. This was achieved through constant conversations, observations and a series of stakeholder meetings. One of the major reasons for stakeholder engagement was to understand different perspectives to establish what had been done and what is needed for the MSDAT to be developed and implemented. Beyond the purpose of having key health indicator data in a single resource, the MSDAT platform provides ease in comparing data from various sources.

Basically, with the development of the MSDAT, information is provided for all stakeholders in the health system, enabling them to make use of the data in making decisions for the Nigerian health system. The platform ensures transparency of health data. To address the issues of privacy and security, the stakeholders were made aware of how data was sourced, used, stored and shared.

Development of selection criteria for data sources and indicators

In order to govern the development and secure the credibility of the MSDAT platform, the E4E team developed selection criteria for the inclusion of health indicators and data sources on the MSDAT platform. These criteria were centred around;

1. National relevance: An indicator or data source would be included if it would inform health issues of concern to the nation and/or if it helps to track health priorities from the National Health Strategic Development Plan (NHSDP).
2. Global health interest: An indicator or data source would be considered if it speaks to global health interests, as long as the data is published by authorised entities in the health sector.
3. Availability of datasets: Indicators with comprehensive datasets would be prioritised for inclusion in the platform.
4. Specific requests from the DHPRS-FMoH and other relevant stakeholders.

Institutionalization of the platform

To establish the use of the MSDAT platform as the convention or norm for health data analytics - especially by the FMoH and partner agencies, we embedded the platform within the DHPRS page of the FMoH website. This increased the credibility, ownership and transparency of the platform. By making the MSDAT tool more accessible to various users, the MSDAT team is able to get feedback from all kinds of stakeholders and users on preferred functionalities and data to improve the quality and relevance of the platform. Another initiative was to provide introductions and training sessions across the health sector - at stakeholder committee meetings (including the Health Data Consultative Committee [HDCC] in December 2018) and technical working group discussions.

Stakeholder perception

The MSDAT platform was successfully presented on 29th November 2018 at the Health partners coordinating committee (HPCC) meeting with the Honourable Minister of Health in attendance. The presentations of the MSDAT at the HPCC and HDCC received positive reviews and feedback from health partners and stakeholders. A mobile version of the dashboard has been developed to improve access to the dashboard. After further reviews, the final version of the MSDAT platform was made ready for use and populated with relevant health data from credible sources.

Lessons learned

The implementation of the MSDAT platform is revolutionary. However, establishing the needed buy-in and use of the platform can easily be hindered by several bureaucratic processes and a lack of interest from its primary users. To mitigate such issues, E4E ensured that ownership of the MSDAT platform was established by the DHPRS-FMoH. Also, stakeholder engagement and participation are key, and in most cases, need to be frequent and consistent to establish and normalise the use of any innovation in the public sector.

Recommendations

Given the need for contextual evidence to be made available to policy and decision-makers, it has become imperative for central analytic repositories to be fully adopted and utilised at all levels of governance. It allows for ease of access to health data as well as serves as a one-stop-shop for information by professionals and stakeholders who need it. It is therefore recommended that the platform be continuously improved on and updated with other existing data sources that may be functioning in isolation. Furthermore, the resource should be expanded to accommodate other equally authoritative data sources and indicators that cut across all health system areas.

Conclusion

Policymakers in Nigeria require evidence-based health data from which to make informed decisions because a wide gap exists between policy making and health research. One sure way to the development of the health sector is through data sharing by health professionals, researchers, private organisations and government agencies. This will help reduce costs and improve the quality of research and data analysis.

Central analytic repositories, such as the MSDAT are essential for the improvement of health data quality. By transparently visualising data and trends across multiple sources, data quality and its use are brought to focus so as to reduce variations that exist between different data sources over time and improve the overall understanding of key trends and progress within the health sector.

Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
CAR	Central Analytic Repository
DHPRS	Department of Health Planning Research and Statistics
DMI	Data Management Interface
E4E	eHealth4everyone
EVIPNet	Evidence to Policy Network
FMoH	Federal Ministry of Health
HDCC	Health Data Consultative Committee
HPCC	Health partners coordinating committee
LGAs	Local Government Areas
LMIC	Lower- and Middle-Income Countries
MSDAT	Multi-Source Data Analytics and Triangulation Platform
M&E	Monitoring and Evaluation
NHMIS	National Health Management Information System
NHSDP	National Health Strategic Development Plan
NLP	Natural Language Processing
PQD	Physician Data Query

Declarations

1. Ethics approval and consent to participate: This is not applicable as the study did not involve human participants, human data or human tissue.
2. Consent for publication: This is not applicable as this study does not contain data from any individual person.
3. Availability of data and materials: This manuscript does not contain any data, however the repository the manuscript describes, the MSDAT, can be accessed here:

https://msdat.fmohconnect.gov.ng/central_analytics

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8. Authors' information (optional)

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Figures

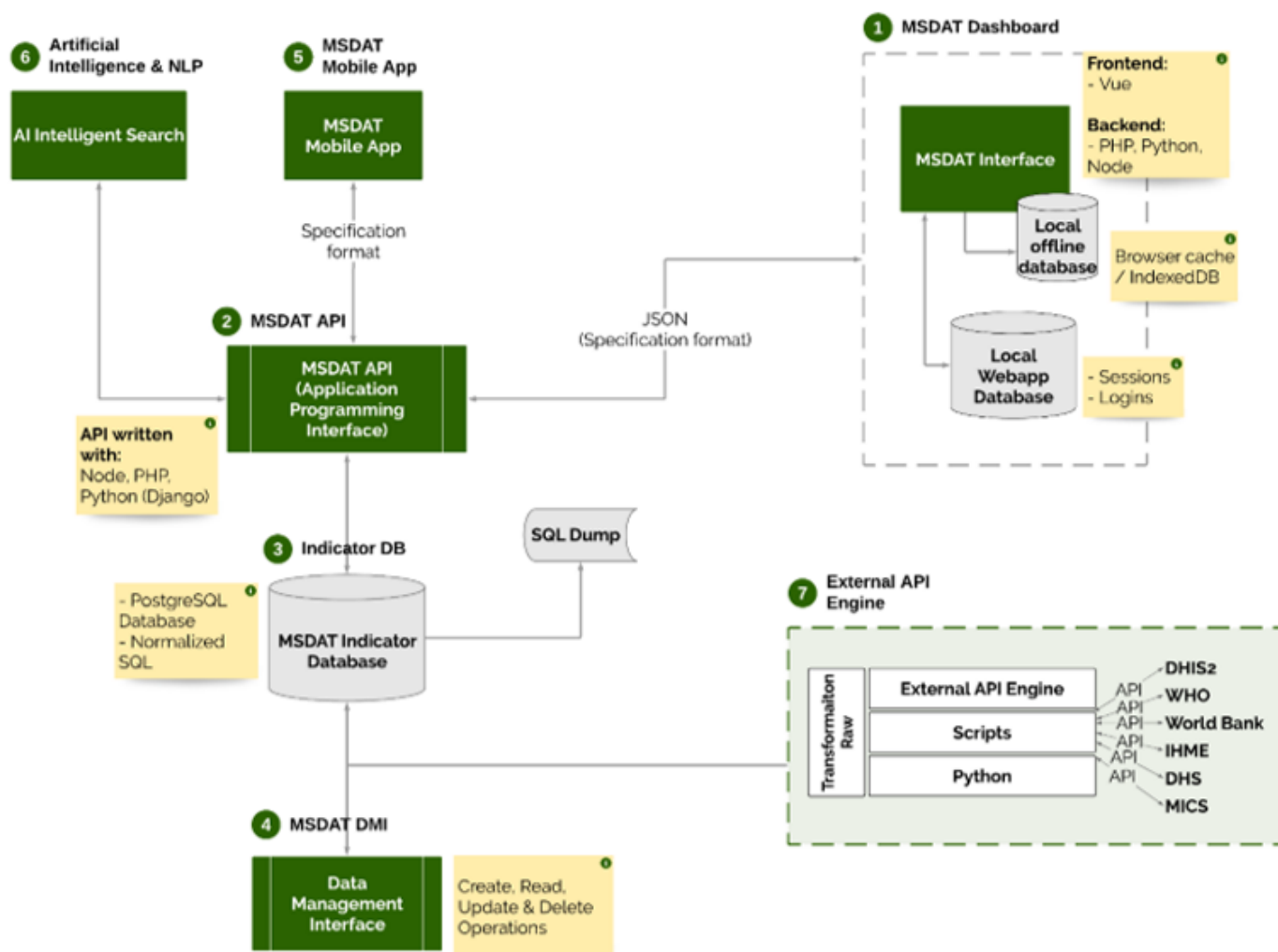


Figure 1

