Geographic Information System as a Tool for Integration of District Health Information System and Drug Logistics Management Information System in Malawi

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Abstract. While the Health Management Information Systems (HMIS) at the national level in Malawi is integrated, separate health information subsystems operate independently at the district level. For instance computerized Information Systems, such as District Health Information System that stores health data and Drug Logistics Management Information System that stores drug logistics data, operate as separate independent systems at the district level. Evidence however shows that information derived from fragmented systems is characterized by poor quality, irrelevancy, unreliability, untimely reporting and therefore inadequacy for management requirements. As one way of addressing problems associated with disintegrated HMIS, organizations worldwide are making collaborative efforts to integrate disparate information systems into one. Hence, this paper discusses possibilities of using Geographic Information System (GIS) to integrate District Health Information System and Drug Logistics Management Information System at district level in Malawi.

Keywords: Drug Logistics MIS, GIS, HIS, Integration.

1 Introduction

Health Information Systems (HIS) are widely recognized as technology enablers, improving patient care coordination, enhancing provider productivity, as well as facilitating knowledge management activities. A multitude of stand-alone administrative and clinical management systems exist, but their true value is realized when they become an integrated electronic health record solution that can address information requirements across multiple functions and sites. HIS include order entry system, drug logistics and management information system, patient record system, anesthesia information management system and disease surveillance record among others.

In Malawi, while the national Health Management Information Systems (HMIS) is integrated, at the district level independent sub systems exist. These are the major cause of fragmentation or 'islands of systems' [1]. These 'islands of systems' are

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invariably highly complex, developed over time as a result of disease burdens and administrative, economic, legal or donor pressures [14, 1].

The international donors and Non-Governmental Organizations (NGOs) come into the resource-constrained public health sector with resources to complement governments' efforts in provision of health care services. These resources are directed towards specific areas and therefore they are organized as independent and vertical programmes which are associated with their own information systems [7]. In Malawi, typical examples are District Health Information System (DHIS) and Drug Logistics Management Information System (LMIS) among others. Consequently, HIS is fragmented with multiple and very often overlapping demands of disease-focused and specific services program systems.

DHIS and Drug LMIS are significant information subsystems at the district level which are not linked to each other or other HIS. They operate as separate autonomous subsystems of the HIS. DHIS is targeted at distributed collection of routine health data from primary health facilities to the district office while Drug LMIS stores drug logistics data at each district pharmacy. District health programme managers frequently need access to information from both DHIS and Drug LMIS from a single point of view for better management in improving health service effectiveness and efficiency. DHIS and Drug LMIS lack effective central co-ordination to ensure that the information which they contain is readily available to the district health programme managers when they need it. Studies done by Galimoto [7] and Chikumba [4] reveal that there is a need for a link or integration between DHIS and Drug LMIS for efficiency and effectiveness.

District health managers, as top management at the district level frequently need instant information from all the subsystems for effective and efficient strategic management decisions. For instance, to get information on surveillance diseases the managers have to access DHIS and for information on drugs and medical supplies status they have to access Drug LMIS. Reports from both systems might not be available at the same time when required by the district health officers due to the stipulated reporting requirements in each subsystem. Health managers are therefore inclined to make uninformed decisions based on inadequate information made available to them at the time needed. As a result of this fragmentation in DHIS, the management reports are likely to provide ineffective, irrelevant, unreliable, untimely and therefore inadequate information that is poor in quality.

One way to integrate the two systems is to use GIS as a tool. Therefore, this paper discusses possibilities of using Geographic Information System (GIS) to integrate District Health Information System (DHIS) and Drug Logistics Management Information System (LMIS) at district level in Malawi.

2 Integration of Information Systems

2.1 Integration

The purpose for two or more software systems integration is to facilitate communication among the systems, information sharing or exchange, as well as system inter-operability in order to achieve a common objective. Integration can bring together things such as services, people, data collection tools, data sets, institutions,

information systems among others [14, 10]. Systems integration is the arrangement of an organization's information systems in a way that allows them to communicate efficiently and effectively and brings together related parts into a single system [13]. With inter-operability and interconnectivity, data generated by any one party can be properly accessed and interpreted by all other parties with standardisation as an important strategy for its achievement.

The integration provides organizations with information consistency in data and processes for an organization's database. The data can be stored in a central warehouse to be accessed by the entire organization and can be customized with appropriate security and controls using available transactions. Worldwide, business organizations are using collaborative efforts to integrate a variety of information systems for a global view of the organization operational environment from a single source [2].

The integration of different information systems in the health operational environment brings together inputs, organization, management and delivery services functions from a variety of managerial or operational activities to health information system (HIS) with an aim to improve efficiency, reliability, timeliness, effectiveness, adequacy and quality services in medical practice [6,7,10,13,14]. In case of Malawi, there is no integration to the national HIS as each system is developed independent of the other in order to achieve its own goals within its operational setting. There are no stipulated standards in the health sector for system development, which can be used as a basis for any system development at any level of operation. As a result, a number of fragmented, disintegrated and heterogeneous systems exist in HIS. Therefore, instead of being used as supporting tools, these fragmented systems hinder the provision of quality health care services delivery.

Health care organizations need cohesion in inter-operations for an integrated access to health information in a unified view at all levels of management. HIS integration in developing countries is impeded with lack of proper technological communication infrastructures in most of the health sector organizations. Most health sector organizations do not have computers for basic record keeping and therefore data is captured manually from its source of data collection [15, 17]. In most health sector organizations where computers are available, a challenge is the existence of disparate systems which operate in isolation of other systems in different departments. There is no network connectivity among various departments to link systems for communication flow to and from each computer.

2.2 Geographic Information System (GIS)

"Almost everything that happens, happens somewhere. Knowing where something happens can be critically important" [11, p. 4]. Geographic Information System (GIS) can acquire, store, manage, and geographically integrate large amount of information from different sources, programmes and sectors. Each piece of information is related in the system through specific geographical coordinates to a geographical entity, for example health facility, and the information can be displayed in the form of maps, graphs, charts, and tables. GIS is a computer based information system with geographical dimension and it stores, manipulates and analyses spatially linked data

and displays summary information on a map [20]. GIS accesses spatial and attribute information, analyses it, and produces output with mapping and visual display [16]. It has very powerful functions such as generating "thematic maps", for example, allowing for overlaying of different pieces of information; creating buffer areas around selected features; calculating distances between two points; and permitting dynamics link between databases and maps so that data updates are automatically reflected on maps.

Many literatures [3,5,8,11,12,18,19] have discussed about challenges, opportunities and strategies of developing and implementing the GIS in developing countries. Government agencies have discovered that how the GIS is implemented influences its successful usage and although implementation involves a considerable degree of technical issues, they are equalled or surpassed by organisational issues [19]. Croswell [3] argues that the technical side of system implementation and operation is considered "minor" as compared to organisational and institutional problems while standards and data integration are considered very important.

Data collection is one of the most time-consuming and expensive tasks of the GIS but very important as emphasised by Saugene [18] that the effectiveness of the GIS depends on the degree of relevant data as input. In many ways data acquisition can potentially be one of the more difficult and costly issues in the implementation of a GIS [12]. Power of the GIS application relies on the scope and quality of data used and the data should be always available and easily accessed when required. To fully realise the capability and benefits of the GIS technology, spatial data needs to be shared and systems must be designed and used by multiple organisations. According to Ginger [8] and Croswell [3], data exchange standards have key role to play for facilitating the integration of datasets from various distributed sources or organisations and lack of these required standards between organisations impedes data sharing.

3 Methodology

The framed experiment was the one used in this research with the focus on the following: (a) non-standard subject pool which consisted of pharmacy technicians, statisticians and pharmacy-in-charge; (b) experiences and information that the subject pool has with emphasis on the GIS and computer operations; (c) the GIS prototype treated as a new commodity to the drug logistics and health staff; and (d) demonstration of the GIS prototype to the subjects in their respective working places and subjects participated and provided feedback and comments.

The interviews were conducted with the aim of understanding working practices of the drug logistics staff and in the hierarchical manner starting from Regional Medical Stores (RMS) in Blantyre, in the southern region of Malawi, down to its district pharmacies and district health offices (DHO) in Blantyre and Mulanje districts, and then two health centres in each of the two districts. Interviews were pharmacy-in-charge, pharmacy technicians, statisticians, and health centre-in-charges respectively. This was supplemented by analysis of health and drug logistics data collection forms and some monthly summary reports from the Drug LMIS software called "Supply Chain Manager" and direct observation on its data entry and reporting at Blantyre district pharmacy aiming on finding out how it handles drug logistics data.

Data was also collected through the evaluation of a GIS prototype whose spatial data was collected from the Department of Survey and Roads Authority. The GIS prototype was demonstrated to pharmacy technicians and statisticians from the Blantyre DHO and the pharmacist-in-charge from RMS in their respective working places. It was performed by applying the DECIDE framework [21] and drug logistics and health data of September 2008 was used. The demonstration focused mainly on (a) reporting and analysis of drug logistics information and (b) integration of spatial, drug logistics and health data. After the demonstration participants were interviewed for their feedback on the proposed GIS.

4 Findings

4.1 The Drug LMIS

The drug LMIS has health facility, district, regional and national levels. The drug logistics data is collected at the health facility level and processed at the district level (district pharmacy) using different tools in order to produce required logistics information for decision making. A responsible level reports in every month to its upper level which is supposed to send feedback to the lower level and concerned stakeholders (*see Fig. 1*).

The drug logistics data is collected at a health facility by health staff using LMIS forms at the end of every month. Then LMIS forms are sent to the district pharmacy for processing and analysis using the computerized system, Supply Chain Manager. This system generates different type of reports that are sent as hard copies to Regional Medical Stores (RMS), district health management team (DHMT), and some stakeholders on monthly basis and on request. The district pharmacy uses these reports to respond to all emergency orders from health facilities and redistribution of some health commodities from overstocked to understocked health facilities. RMS uses the same information to decide on the monthly distribution of health commodities to health facilities.

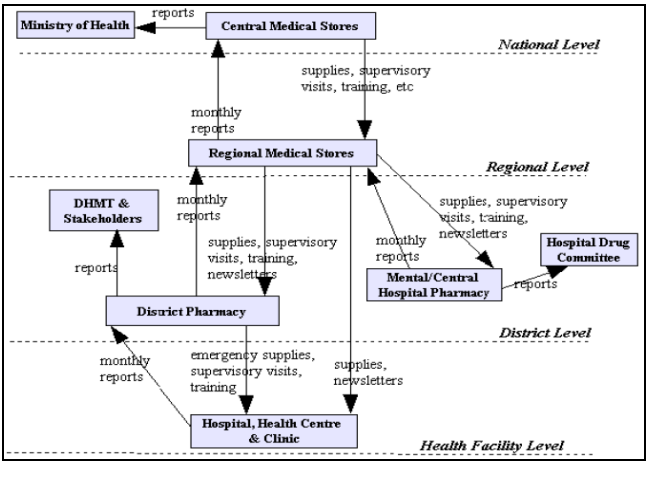

Fig. 1. Information Flow and Feedback between Levels in the Drug LMIS

4.2 Health Management Information System

In the health management information system (HMIS), as shown in the Fig. 2, the information is originated from the health facilities and sent to the district health office (DHO) and then the Ministry of Health. The lower level receives feedback accordingly from the higher level.

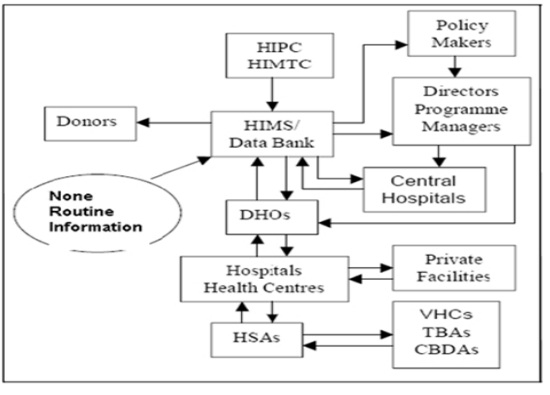

Fig. 2. Information Flow in Health Information System in Malawi
(**Source:** Ministry of Health and Population, 2003b, p. 21)

A catchments health facility collects data from all public and private facilities in its catchments area and performs analysis on monthly basis and takes necessary actions aimed at improvement in management of health programmes. The district health office receives data and reports quarterly from all catchments health facilities in its district. By using a computer system called District Health Information System (DHIS), a statistician compiles reports quarterly which are used for decision making at the district level. The district health offices and central hospitals send the raw health data quarterly to the Ministry of Health for data analysis at the national level.

4.3 Similarities and Differences between Drug LMIS and HMIS

By comparing the HMIS with the drug LMIS, there exist similarities and differences as explained below:

- *Data Collection:* In both systems, data is collected at the health facility level by the same health staff on daily basis while performing their official duties but the drug LMIS uses different forms for data collection from those used in the HMIS. The HMIS uses catchments health facility as a data collection point in a particular catchments area and any other health facilities report to it except the central and mental hospitals. The drug LMIS uses any health facility as a data collection point provided it gets health commodities from a district pharmacy and/or the regional medical stores. At the end of each month the both logistics and health data are aggregated and analysed ready to be forwarded to the upper level.
- *Reporting:* Both logistics and health data from the health facilities in a district are sent to the district health office for data analysis at the district level and then to be

used by the district health management team and stakeholders. The logistics data is sent monthly to the pharmacy technician or assistant while the health data is sent quarterly to the statistician. From the district health office, the health data is sent quarterly to the Ministry of Health while the logistics data is sent monthly to the regional level (regional medical stores) and then to the Central Medical Stores and Ministry of Health.

- *Data Processing at district health office:* It was observed that the most of data processing is done at the district level using computer software systems. The statistician uses the DHIS to compute the health data and the pharmacy technician uses the Supply Chain Manager to process the logistics data. Both systems were developed in Microsoft Access.

5 Integration of DHIS and Drug LMIS

The data integration is a new work process to be introduced due to the introduction of the GIS. This integration can be analysed in two ways: (1) integration of spatial data and attributes; and (2) integration of spatial data, drug logistics data and health data (*see Fig. 3*). It is also important to integrate the spatial data especially the health facilities with the drug logistics and health data. The GIS prototype has demonstrated this integration but there are some options that could be also considered.

The logistics and health data at the district level is not integrated in any way. The drug LMIS and the health information system are separate systems. The district health management team uses both the logistics and health data for decision making and the drug logistics staff also requires health data. Therefore, the proposed GIS can be used as an integration tool to link the logistics and health data together through a common geographical reference system of health facility. At the district level, the Supply Chain Manager and DHIS are used for logistics and health data management respectively and both systems use Microsoft Access database management system which can easily be linked with majority of GIS databases.

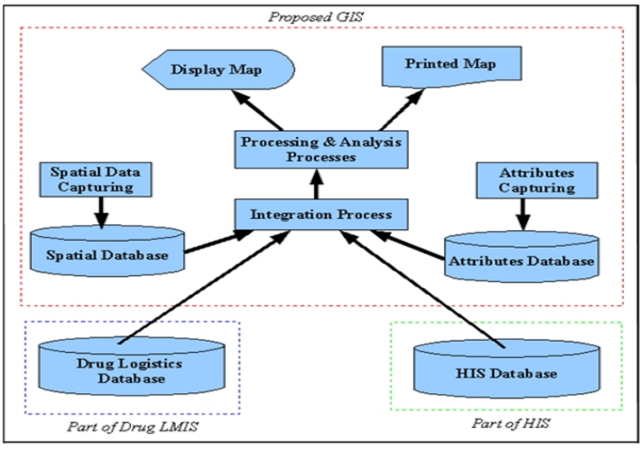

Fig. 3. Integrating Databases of GIS, Drug LMIS and HIS

Two options have been suggested: (1) integrate the spatial data with the drug logistics and health data as shown in Fig. 3 and in this case the proposed GIS requires an interface to access data from all databases; and (2) first integrate the drug logistics data with health data, and then integrate results with the spatial data.

It has been observed that the main new work processes, due to the introduction of the GIS in the drug LMIS, include the spatial data collection, data integration and data management. These processes are the most time-consuming and expensive GIS tasks but very important because effectiveness of the GIS depends on the degree of relevant data as input. For the district health office to successfully implement the GIS in the drug LMIS, it is important to consider carefully data standards and integration between the GIS, drug LMIS and health information system.

As shown in Fig. 3, there are four databases for spatial, attributes, drug logistics data and health data that are integrated at a single point. A common identifier is required in all databases for easy integration and management. It is necessary to determine standards for a common identifier, in this case the health facility and naming of different features such as health facilities, pharmacies and districts. All databases should use common codes and names for health facilities and pharmacies. If this is to be implemented, it means that the district health office will have a lot of work to modify all codes and names of health facilities and pharmacies in the drug LMIS and HIS to match with those in the spatial database.

Hence, the district health office needs to modify some existing policies and standards in the drug LMIS and HIS in order to come with common policies and standards for coding and naming of those health facilities and pharmacies. If there is a certain change in the health facility, it will be necessary to update all databases in order to maintain data consistency and this update will be in hands of two offices which are hard to coordinate, the pharmacy technician (for drug logistics databases) and statistician (for health database). Since both the drug LMIS and HIS will not only be used to feed the GIS, it is important to make sure that the databases have complete data, for example full descriptions of health facilities and pharmacies, for other services. Therefore, when it is needed, for example, to change a name of pharmacy or health facility, all databases should be updated and likely, missing changes in some databases which will result in data inconsistency.

Another challenge is a definition of data collection points in the drug LMIS and HIS as experienced in the GIS experiment. In HIS data is collected from the catchments health facility while in drug LMIS data is collected from any health facility which gets health commodities from either RMS or district pharmacy. It means that to integrate data from the two systems, it is required to define common collection points for both drug logistics and health data. Otherwise data from some health facilities, that are not data collection points in either one of the systems, will not be considered in the GIS because it will be difficult to integrate them.

6 Conclusion

Currently, drug LMIS and DHIS are separate systems at the district level and it is necessary to integrate them in order to be effective to the district health management team and other stakeholders. Both health programme managers and drug logistics

staff require both health and drug logistics data in their daily works. It is possible to integrate drug LMIS with DHIS at district level in Malawi using GIS but there are some challenges such as (1) changing of some existing policies and standards in the drug LMIS and HIS in order to come with common policies and standards for coding and naming of those health facilities and pharmacies and also daily work practices; (2) definition of data collection points in the drug LMIS and HIS since each system defines its data collection point differently; and (3) choosing very suitable option for the integration.

References

1. AbouZahr, C., Boerma, T.: Health Information Systems: the foundations of public health. Bulletin of World Health Organisation 83, 578–583 (2005)
2. Chaulagai, C.N., Moyo, C.M., Koot, J., Moyo, H.B.M., Sambakunsi, T.C., Khunga, F.M., Naphini, P.D.: Design and implementation of a health management information system in Malawi: issues, innovations and results. Oxford University Press, London (2005)
3. Croswell, P.: Obstacles to GIS Implementation and Guidelines to Increase the Opportunities for Success. Journal of the Urban and Regional Information Systems Association 3(1), 43–56 (1991)
4. Chikumba, P.A.: Application of the Geographic Information System (GIS) in the Drug Logistics Management Information System (LMIS) at the district level in Malawi: Opportunities and Challenges, Master Thesis, University of Oslo (2009)
5. Forster, M.: Review of the use of Geographical Information Systems in the Marketing and Planning of Logistics Services. Christian Salvesen Logistics Research Paper no. 3 (September 2000)
6. Fumo, T.G.: Health Information Systems Integration: A Data Warehouse Architecture Model for the Ministry of Health in Mozambique. Master Thesis, University of Oslo (2003)
7. Galimoto, M.S.: Integration of Health Information Systems, Case Study from Malawi. Master Thesis, University of Oslo (2007)
8. Ginger, L.J.: Introducing Geographical Information Systems for Health Care in Developing Countries: Challenges and Approaches, A case study from Mozambique. Master Thesis, University of Oslo (2005)
9. Johnson, C.P., Johnson, J.: GIS: A Tool for Monitoring and Management of Epidemics. In: Map India 2001 Conference, New Delhi (2001)
10. Kuhn, K.A., Giuse, D.A.: From Hospital Information System to Health Information System: Problems, Challenges, Perspectives. Method. Inform. Med. (4) (2001)
11. Longley, P., Goodchild, M., Maguire, D., Rhind, D.: Geographic Information Systems and Science, 2nd edn. John Wiley & Sons, Ltd (2005)
12. Mennecke, B.E., Crossland, M.D.: Geographic Information Systems: Applications and Research Opportunities for Information Systems Researchers. In: Proceedings of the 1996 Hawaii International Conference on System Sciences, HICSS-29 (1996)
13. Meyer, M., Levine, W.C., Brzezinski, P., Robbins, J., Lai, F., Spitz, G.: Integration of Hospital Information Systems, Operative and Peri-operative Information Systems, and Operative Equipment into a Single Information display. American Medical Informatics Association (2005)
14. Nyella, E.: Challenges and Opportunities in the Integration of HIS: A case study of Master Thesis, University of Oslo (2007)

15. Odhiambo-Otieno, G.: Evaluation of existing District Health Management Information Systems: a case study of District Health systems in Kenya. International Journal of Medical Informatics 734 (2005)
16. Pick, J.B.: Geographic Information Systems in Business. Idea Group Publishing, Hershey (2005)
17. Sandvand, J.: Organisational Strategies for Improving Health Information at the district level: a field study of management Implemented support structures in Malawi. Master Thesis, University of Oslo (2007)
18. Saugene, Z.B.: Challenges, Opportunities and Strategies for Using Geographic Information Systems for Public Health Management - An Action Research Study from Mozambique. Master Thesis, University of Oslo (2005)
19. Sieber, R.E.: GIS implementation in the grassroots. Journal of the Urban and Regional Information Systems Association 12(1), 15–29 (2000)
20. Wood, D.J., Gatrell, A.C.: Equity of geographical access to inpatient hospice care within North West England: A Geographical Information Systems (GIS) approach. Institute for Health Research, Lancaster University, England (2002)
21. Sharp, H., Preece, J., Rogers, Y.: Interaction Design: Beyond Human Computer Interaction, 2nd edn. John Wiley & Sons (2007)