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The What, Why, and How of Health Information Systems: A Systematic Review

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Abstract: *The literature on the topic of health information systems (HISs) is reviewed in this paper. Specifically, the paper reviews the literature on (i) the theoretical concept of HISs (The What), (ii) the rationale, purposes, and importance (The Why), and (iii) the operationalization of the HISs (The How). For this systematic review, we searched Research Gate, Science Direct, Google Scholar, JSTOR, ProQuest, Scopus, PMC, BMJ, PubMed, and published documents by World Health Organization (WHO). Only 35 articles out of 1,400 articles identified were included in the study depending on the 3 contextualised questions i.e., the what, why, and how of the HISs. Literature published between 1960 and 2021 were considered in the review as the concept of HIS was introduced in the 1960s, excluding literature published before the 1960s and non-English publications. Generally, the HISs is one of the six pillars that make up a strong health system, designed to collect, process, store and manage health information. The main goal of the HISs is to deliver quality services. The importance of these systems includes quick access to medical records, sharing of patient information, reducing paperwork, reducing medical errors, improve the quality of care. Therefore, there is a great need to promote this concept, taking into account its rationale, purposes, and importance of it in the health care system.*

Keywords: *health information systems, health system, health service delivery, systematic review*

1.0 Background Information

Health information systems (HISs) have been defined in different ways by various authors all over the world. The World Health Organization has defined HISs as the system that collects data from the health industry including clinics, dispensaries, health centres, and hospitals; whereby gathered data are analyzed to ensure accuracy, relevance, and time-bound, and the data is then transformed into useful information that may be utilized to make decisions related to health (WHO, 2008). HISs is the system that facilitates capturing, storing, sharing, and retrieval of patient health information (Ayabakan *et al*., 2017). According to Tossy (2014:3), HISs is stated as "the intersection between healthcare business process and information systems to deliver better services, is a set of components and procedures organized to generate information which will improve health care management decisions at all levels of the health system".

HISs capture a variety of information including patient information, laboratory test results, diagnosis report, treatment, medical history of the patient, and appointments. Thus, the information captured through HISs is used to assist in the delivery of health services (Panerai, 2014). HISs are critical to the efficient operation of health care systems around the world (Hodge, 2012). They are considered to have an impact on strengthening the health system and health services provision in particular (Haule and Muhanga, 2021). The key function of the health system is to ensure the accessibility of health services with better quality (WHO, 2008). The integration of information systems in the health sector plays a vital role to deliver quality health services through HISs (Sayyadi *et al*., 2021). Therefore, HISs facilitate the provision of health services. HIS's goal is to provide high-quality services, timely and accurate information, and clinical data sharing to help patients receive the best care possible. The purpose of intervention of these systems in the health sector is "to document data that are routinely collected in health facilities using the system" (Dehnavieh *et al*., 2019:2).

Health information systems are important in the health industry since they are required to collect, store, and manage health information, and ensure access to health data for decision-making and provision of service. HISs provide better health information for better decisions regarding health for better health. A quality population is determined by good health among individuals, albeit good health is largely dependent on the quality of health-care services provided, which is highly influenced by the use of health information systems (Muhanga and Mapoma, 2019). The provision of quality health services is essentially observed to

have a significant contribution to health improvement in society (Smith *et al*., 2008).

Although the notion of HISs and their applications in the health business are critical, most dispensaries, health centres, and hospitals, both public and private, have been unable to fully adopt and utilize these systems. HISs has the potential to strengthen any country's health system, hence they must be promoted. The subject of this paper is to discuss the concept of health information systems (The What), their importance, purposes, and rationale (The Why), and how they operate in health care settings (The How) by conducting a literature review on the topic.

2.0 Methodology

A systematic review was employed in this study. The approach entails categorizing, evaluating, interpreting, and comprehending cohort studies as well as the limitations of textual materials for the specific topic. In addition, the method is thought to be a more cost-effective strategy than other methods (Bohnsack *et al*., 2010; Mogalakwe, 2006). In the search for relevant scholarly published articles, several search engines and databases were searched, including Research Gate, Science Direct, Google Scholar, JSTOR, ProQuest, Scopus, PMC, BMJ, PubMed, and published documents by World Health Organization (WHO). In reviewing the literature, terms such as "health information system, health system, service provision, the definition of health information system, types of health information system, history of health information system, purposes of health information system, the importance of health information system, assessment, and operationalization of health information system" were utilized to locate previously published documents and journal publications that were relevant.

Literature published between 1960 and 2021 was considered in the review because the concept of HIS was introduced in the 1960s. The exploration excluded literature published before the 1960s and non-English publications. In the literature, a total of 1,400 references were located that were relevant to a set of search phrases under the what, why, and how of HISs. Only 35 of the 1,400 retrieved references and abstracts met the requirements for inclusion. Figure 1 shows the total number of publications identified, excluded, selected, and included for this study.

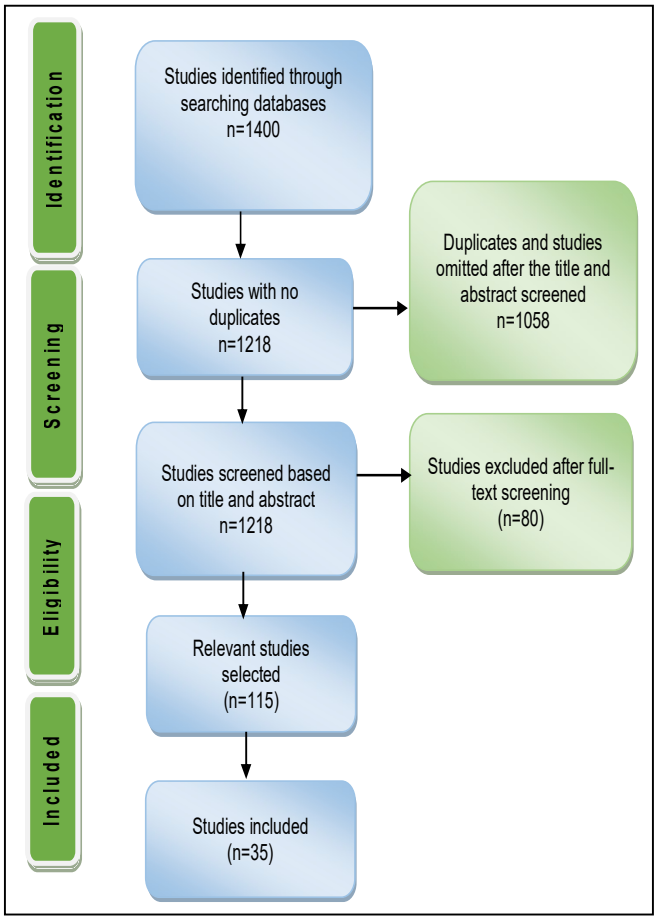

Figure 1: Procedure of systematic review

3.0 Findings and Discussions

3.1 The concept of a health information system

A health information system is one of the six pillars that make up a strong health system, also a core building block among others which are health services delivery, health workforce, health system financing, leadership and government, and access to essential medicine (WHO, 2008). A strong health system starts with a well-designed and integrated health information system (Hodge, 2012). Few developing countries, on the other hand, have adequate or functional health information systems. HISs provide better health information, whereas sound and reliable information are useful for decision-making related to health (WHO, 2010).

The World Health Organization described the key functions of HISs as data collection, compilation, analysis, communication, and use, where HISs collect data from the health industry, analyze it, and translate it into information, resulting in a report that informs service providers, decision-makers, and policymakers about health planning, monitoring, and evaluation, as well as the service provision (WHO, 2010). Also, HISs comprises six components such as HIS resources, Indicators, Data sources, Data Management,

Information production, dissemination, and use, which facilitate the delivery of services (WHO, 2010).

HISs is designed and implemented in various health facilities and hospitals to manage routine health data. The extent of implementing, integrating, and adopting HISs is rapidly growing around the entire world and in different countries including Tanzania. HISs provide better health information, whereas sound and reliable information are useful for decision-making related to health (WHO, 2010). Hodge argues that better information leads to a better health-related decision, while better decision leads to better health (Hodge, 2012). However, globally, HISs have been observed to have difficulties in delivering accessible, manageable, and quality services due to poor infrastructure, fewer trained staff on HIS, and inadequate ICT infrastructure (WHO, 2017).

3.2 Health Information Systems Categories

HIS can be divided into two main categories, Electronic medical/health records (EMR) and Clinical decision support system (CDSS) (Dehnavieh *et al*., 2019; Vaganova *et al*., 2017).

3.2.1 Electronic medical/health record (EMR)

EMR is a type of health information system that collects, processes, and stores patient medical records or information electronically. EMR is a computerized version of a patient's paper-based record. The practitioner can use electronic records to track the patient's health over time, receive input from other consulting physicians, or recall clinical assessments from a prior day or hospital visit. A patient's medical history, diagnosis, prescriptions, radiology pictures, treatment plans, appointments, allergies, and laboratory and test results are all stored in an electronic health record (EHR). The system makes information available to authorized users immediately and securely (Vaganova *et al*., 2017; Tang and McDonald, 2006).

3.2.2 Clinical decision support system (CDSS)

CDSS organizes clinical data, facilitates data sharing, and assists physicians in making better clinical decisions. Medical practitioners receive frequent reminders and recommendations from clinical decision support to enhance service delivery. The patient's screening tests may be recommended through a decision support system. Clinical decision support (CDS) delivers timely information, to aid health providers in making healthcare decisions for patients (Vaganova *et al*., 2017; Addo and Agyepong, 2020). Laboratory information systems (LISs) that emphasize essential care values or pharmacy information systems (PISs) that present an alert ordering a new medicine and suggesting a probable drug-drug interaction are examples of such CDSS (Wasylewicz and Scheepers-Hoeks, 2019).

3.3 Purposes, importance, and rationale of health information systems

3.3.1 Purposes of HISs

Health information systems are used for a variety of purposes. The main goal of HISs as one of the six health system building blocks is to deliver quality services, provide timely and precise information, and share clinical data to contribute to efficient patient care (Archangel, 2007: WHO, 2010). The collected data from different sources and information generated through HISs are used by decision-makers at all levels of the health system, "to identify problems and needs, make evidence-based decisions on health policy and allocate scarce resources optimally" (WHO, 2010:4).

The aim of implementing health information systems in health facilities is to provide fast and precise data that may be shared to guarantee optimal patient care, as well as remote data access for decision-makers (Archangel, 2007; URT, 2017). Furthermore, Vaganova and others in their study, stated that the major goals of HISs use are to improve treatment efficiency (by minimizing medical errors) and to reduce diagnostic and treatment costs, which include health and clinical management and patient records (Vaganova *et al*., 2017).

3.3.2 Importance of HISs

The significance of health information systems being able to generate accurate data and influence service delivery is becoming more widely recognized as the answer to the question of why health information systems are in the health industry. The importance of these systems includes simple and quick access to health information or records; HISs make it simple for healthcare practitioners to obtain information regarding health such as patient records, community health patterns, diseases, and available drugs (Ahmadian *et al*., 2017). For example, quick access to a patient's medical history can give information about prior treatments for effective patient care.

Sharing of patient information is one of the benefits of a health information system as it reduces costly redundant test, information can be accessed remotely by decision-makers, also the use of the system allow health record to be shared among health providers and patients (Ahmadian *et al*., 2017; Menachemi and Collum, 2011).

The health information systems automate all records and reduce paperwork, it improves documentation quality, unlike paper-based documentation as it saves space, reduces the workload to workers to sort paper records, and it saves time; HISs provide an expanded database that contains a huge amount of routine data collected from health facilities (Ahmadian *et al*., 2017).

The use of these systems reduces errors, particularly medical errors caused by poor penmanship of physicians (Menachemi and Collum, 2011). Health providers perceived that without a health information systems medical errors increase while the use of the system reduces medical errors.

Also, HISs help to improve the delivery of services and increase the quality of care as it comprises the management system that influences the delivery of service. It improves patient safety and hence contributes to service delivery because HISs provide quick access to patient data, you can save all of the data and distribute it across numerous databases to improve patient safety (Menachemi and Collum, 2011; Gatner *et al*., 2017; Orang'i *et al*., 2019; Gesulga *et al*., 2017).

3.4 Operationalization of health information systems

The operationalization of health information systems can be explained using the two categories of HISs: electronic medical/health record (EMR) and clinical decision support system (CDSS).

3.4.1 EMR operationalization

Health-related information such as a patient's medical history, diagnosis, prescriptions, radiology pictures, treatment plans, appointments, allergies, laboratory, and test results are collected in a digital format using an EMR system. The collected information is then processed and stored in the system (Vaganova *et al*., 2017). EMR records information of the patient from the admission process up to the discharge process. When need to be used, authorized users such as service providers, medical practitioners, and doctors can access the information immediately either to track the patient's health over time, receive input from other consulting physicians, or recall clinical assessments from a prior day or hospital visit. Records stored in these systems can be shared and accessed within different health facilities through network-connected or cloud-based systems (Vaganova *et al*., 2017; Tang and McDonald, 2006). Also, EMR guides health professionals to identify the trending diseases, frequent drugs used, as well as the number of patients served in a particular health facility.

3.4.2 CDSS operationalization

Information collected through an electronic medical/health record system (EMR) is analyzed by CDSS to give suggestions, computerized alerts, and reminders to help health providers follow evidence-based clinical recommendations when delivering health services. The information available in these systems is then used by medical practitioners, staff, doctors, and clinicians to make better clinical decisions to enhance service delivery (Vaganova *et al*., 2017; Addo and Agyepong, 2020). The system allows clinicians to integrate their knowledge with information or recommendations offered by the CDSS to enhance the provision of healthcare. The patient's screening tests, medicine to be used by the patient according to the symptoms identified, and alert on ordering a new medicine drug interaction, are recommended through the decision support system (Wasylewicz and Scheepers-Hoeks, 2019).

3.5 Quality of health information systems

Any information systems adopted and implemented at the facility level or country level must be of high quality. The standard indicators for the quality or success of an information system are satisfaction, response time, learning ease, integration, and ease of use (Elsadig *et al*., 2019). The system quality, according to Technology Acceptance Model (TAM), is considered an external factor that influences behavioural beliefs regarding the system (Charness and Boot, 2016). The quality of the system has a significant impact on users' acceptance and willingness to utilize it (DeLone and McLean, 1992). TAM describes that the user's willingness to use the new technology is determined by two factors; the effectiveness and user friendly of the system Charness and Boot, 2016; Belardo *et al*., 1982). Therefore, a study conducted by Elsadig and others suggested that it is essential to examine the quality of information systems (Elsadig *et al*., 2019).

A study by Ojo was conducted to examine the system quality using DeLone& McLean (D&M) quality model in the context of health information systems in developing countries (Ojo, 2017). Results showed that "system quality significantly influence use ($\beta = 0.53$, $p < 0.001$) and user satisfaction ($\beta = 0.17$, $p < 0.001$). Information quality significantly influence use ($\beta = 0.24$, $p < 0.001$) and user satisfaction ($\beta = 0.17$, $p < 0.001$). Also, service quality significantly influence use ($\beta = 0.22$, $p < 0.001$) and user satisfaction ($\beta = 0.51$, $p < 0.001$)" (Ojo, 2017:1). The quality and utilization of the system were determined to be crucial indicators of a successful information system. Thus, to achieve the HISs goal; the system should be made to be simple to use, functional and flexible.

The study on the role of perceived system quality, according to Islam, the results were "perceived system quality ($\beta=0.39$, $t = 6.78$, $p < 0.001$) had a significant effect on perceived usefulness, perceived usefulness ($\beta=0.22$, $t = 4.22$, $p < 0.001$) and perceived system quality ($\beta=0.45$, $t = 8.87$, $p < 0.001$) significantly influenced satisfaction, Perceived usefulness ($\beta=0.48$, $t = 7.86$, $p < 0.001$) and satisfaction ($\beta=0.38$, $t = 5.85$, $p < 0.001$) had a significant influence on intention, Interestingly, perceived system quality ($\beta=0.07$, $t = 1.06$, ns) had no significant influence on intention" (Islam, 2012:35). Therefore, the health information systems are likely to be used and embraced in the health sector considering the two factors: perceived usefulness and user satisfaction.

3.6 Health Information Systems in Developed World: An Overview

In the developed world health information systems are widely incorporated into the health sector, and through the years, the urge had emerged for stakeholders to harmonize the mechanism and the tools for which the intended goals could be generated from the HISs. Health information systems support evidence-based policy and decision-making in EU health care settings. [32] An EU health information system as defined by WHO is "*an integrated effort to collect, process, analyze, report, communicate and use comparable health information and knowledge covering all Member States to understand the dynamics of the health of EU citizens and populations to support policy and decision-making, program action, individual and public health outcomes, health system functioning, outputs and research in the European Union*" (WHO, 2003).

Bridging Information and Data Generation for Evidence-based Health (BRIDGE Health) has called attention to the need to improve the EU's health information system. BRIDGE Health's mission is to analyze the current situation and consider the options for forming an organization to take on the tasks associated with the need to strengthen the EU's health information system (Bogaert and Van Oyen, 2017). Despite these countries' successes in the health sector, the current EU health information system is severely fragmented, and it lacks long-term viability, comprehensiveness, and consistency.

The health information systems in European countries are unique, however, they confront similar healthcare system issues. A study conducted by Bogaert identified the main barriers to the well-functioning of HIS in the developed world; a shortage of trained personnel on HIS, EHR-implementation roadblocks, data source fragmentation, gaps in legislation, and limited data accessibility and use (Bogaert *et al*., 2021).

3.7 Health Information Systems in the least Developed Countries: An Overview

Most countries have quickly adopted HISs, and their use has expanded as a result of their impact on enhancing patient safety, delivering high-quality treatments at lower costs, and managing patient data (Hodge, 2012). The availability of more durable, cheaper, and lower-power hardware, as well as improved internet connectivity, electricity, and the advent of open-source software, have all contributed to its recent expansion in the least developed countries. Examples of HISs implemented are District Health Information System (DHIS), Open ELIS, Baobab Health Trust, OpenMRS and Smartcare are just a few of them, and they're all in use in a variety of locations across the globe. However, the adoption rate and utilization of HISs in the least developed countries are quite low (Menachemi and Collum, 2011).

Even though HISs is being embraced and used in developing nations, as evidenced by the proliferation of different e-health systems over the last two decades, HISs are still regarded as inadequate and underutilized. With difficulties in delivering accessible, manageable, and quality services due to poor infrastructure, poor management, fewer trained staff on HISs, and inadequate ICT infrastructure to enable HISs to work effectively in enabling the delivery of healthcare (WHO, 2017). Human resource issues, insufficient health budget allocation, poor management, and infrastructure are among the primary challenges that African health systems confront, according to Smith *et al*., (2008).

Health information systems in the least developed nations are increasingly finding it challenging to generate high-quality data, therefore obtaining reliable and accurate health-related information is difficult, hence poor decisions related to health and planning, which results in poor health as well as service provision to the community.

3.8 Health Information Systems and Health Services Delivery: Prospects and Challenges

3.8.1 Prospects of health information systems on service delivery

Health information systems are expected to have a significant impact on healthcare service delivery. HISs aid in the improvement of health care quality, efficiency, and effectiveness (Ahmadian *et al*., 2017). These systems enable health professionals to communicate with one another to ensure the flow of health information and the sharing of clinical data required for high-quality healthcare (Orang'i *et al*., 2019). HISs, according to Addo and Agyepong, lower patient waiting time, minimize user burden and provide faster medical records, all of which improve patient care (Addo and Agyepong, 2020). Patient information gathered by HISs is accessed by health workers to make it easier for them to provide services, but information may also be shared across many databases and contexts to improve patient safety as well as healthcare services delivery (Gesulga *et al*., 2017; Ondieki, 2017).

3.8.2 Challenges of health information systems and their effect on service delivery

The challenges connected with HISs may have a greater impact on service delivery and patient outcomes. Problems with system functionality including poor user interface and complexity, access to the system, and software update issues are causes of delayed care (Ahmadian *et al*., 2017; Menachemi and Collum, 2011). Inadequate ICT infrastructures cause problems with HISs integration and usability, which impedes HISs use and, as a result, impairs system utilization and service delivery (Panerai, 2014). Problems in system operations due to poor internet

infrastructure affect the performance of HISs and thus service provision. According to Addo and Agyepong in their study findings on the effects of ICT on service delivery; Lack of ICT services and infrastructure, poor internet connections, and scarcity of ICT personnel could impede the use of HIS in delivering high-quality services (Addo and Agyepong, 2020). Moreover, financial constraints and lack of policies to support the health system results in a weak health system and, as a result, poor quality of health services delivery.

4. CONCLUSION AND RECOMMENDATIONS

Strengthening the health system and improving service delivery can be challenging without incorporating HISs into the healthcare sector. These systems form the foundation of any country's strong health system, as well as the quality-of-service delivery, but they must be adequate and functional. HISs give better data, which leads to better health decisions, hence encouraging their acceptance and deployment in hospitals around the world is critical. There is a great need to promote this particular concept, taking into account its rationale, purposes, and importance of it. As a result, decision-makers, policymakers, and other stakeholders must take the lead in promoting this concept: The What, Why, and How of Health Information Systems.

Conflict of Interests

The authors disclose that they do not have any competing interests.

Authors' contributions

CDH and MIM contributed significantly to the manuscript's conceptualization and design. CDH drafted the manuscript after reviewing documents containing information on the topic under investigation. The first draft of the manuscript was critically revised by MIM. All authors approved the final version of the manuscript.

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