

EVALUATION OF INTEGRATED HEALTH INFORMATION SYSTEMS
(IHIS): A GENERAL APPROACH WITH APPLICABILITY FOR THE
CARIBBEAN REGION

by

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DALHOUSIE UNIVERSITY
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DEDICATION

To a gracious woman and my ardent supporter, mom.
Your untiring efforts have made the difference, here is evidence.



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ABSTRACT

The countries within the Caribbean region are pursuing the development of national integrated health information systems (iHIS). The model of the Belize Health Information System (BHIS) is referenced as the implementation guide. There are no established standards to facilitate independent evaluation of these types of systems. This study utilizes existing knowledge to determine the common approaches for evaluating health information systems (HIS) and applies these findings to formulate an evaluation approach for these regional systems. This approach is intended to strengthen the regional capacity for evaluating national iHISs by examining the contextual factors and providing an evaluation tool, CHEATS+, for systems lifecycle evaluation.

LIST OF ABBREVIATIONS AND SYMBOLS USED

BHIS	Belize Health Information System
BIKVA	BrugerInddragelse i KVALitetsvurdering (User Involvement in Quality Development)
CARICOM	Caribbean Community
CDB	Caribbean Development Bank
CHEATS	Clinical, Human and Organizational, Educational, Administrative, Technological, Social
CHEATS+	Clinical, Human and Organizational, Educational, Administrative, Technological, Social, plus
D & M	Delone and McLean
HIS	Health Information System
HMN	Health Metrics Network
HOT	Human, Organization and Technology
IADB	Inter-American Development Bank
ICT	Information and Communication Technology
IDI	ICT Development Index
iHIS	integrated Health Information System
IS	Information System
ITPOSMO	Information, Technology, Processes, Objectives and values, Staffing and skills, Management and structures, Other resources
KUBI	KvalitetsUdvikling gennem BrugerInddragelse (Quality Development Through User Involvement)
MEM	Multi-method Evaluation Model
PAHO	Pan-American Health Organization
PRISM	Performance of Routine Information System Management
WHO	World Health Organization

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CHAPTER 1 INTRODUCTION

1.1 OVERVIEW

Health Information Systems (HIS) to address the needs of population health and surveillance are increasingly being implemented globally. The drive for these implementations is no less in the Caribbean region. While this region has been synonymized with cool tropical breezes and white sand beaches, its efforts to achieve success in healthcare services have been less glorious. A recent regional workshop hosted by the Caribbean Development Bank (CDB) to examine the state of affairs and provide direction for developing national HIS gave insight to the desire for attainment and the need for support [1].

One of the primary motivators for implementing HISs is the need for information-driven health sectors. The HIS is designed to address both the administrative and clinical information needs in healthcare delivery [2]. The goal of the national integrated health information system (iHIS) has become the focus of health ministries and departments. Their implementation is a part of the mandate for the World Health Organization through its Health Metrics Network.

While this universal goal has been expressed by health authorities, the local contexts have been influential in the design, methods and best practices applied. The implementation of country-wide HISs in less economically developed countries requires consideration of the customary barriers to implementation [3] and other factors such as limited resources and the socio-political conditions. However, when these systems are implemented it is expected that their use would result in the delivery of improved quality

of healthcare services. The expected results include providing the populations of developing countries with access to healthcare services that meet international standards.

This rise in implementation of the iHIS for national healthcare needs has undoubtedly raised questions about their efficiency and usefulness. Providing answers to these inquiries has been a challenge and is becoming an area of interest for stakeholders involved in the implementation of national iHISs. With these efforts to implement national iHISs in regional countries, it is critical to determine the contingencies for performing evaluations for the national iHIS in this setting.

Evaluating the impact and benefits within the Caribbean Community is important to inform progress within the regional healthcare sector. A significant challenge is the lack of “verifiable indicators of success” which has negatively affected the ability of stakeholders to assess improvements in various sectors across the region [4]. While there are existing guidelines for system composition, an evaluative framework to determine the factors that are integral to the success of implementations in the Caribbean Community (CARICOM) has not been developed. This focus of this paper is to formulate a set of criterion for adequately evaluating national iHISs implementations in less economically developed countries, primarily those in the Caribbean region.

To enable this outcome, this discussion will address the following research objectives: 1) What are the features of national iHISs? 2) How should the evaluation of HISs be performed? 3) What are the available frameworks that can be applied for the evaluation of HISs? 4) What is the evaluation approach that should be applied for evaluating the iHIS in this regional (Caribbean) context?

This study is beneficial for supporting the meaningful implementation of HISs in the Caribbean region. The “Resolution on the Regional Efforts to Strengthen National iHISs for the English-speaking Countries of the Caribbean” [5] outlines the intention of the health ministries of Anguilla, Antigua and Barbuda, Barbados, Belize, British Virgin Islands, Dominica, Montserrat, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago to implement national iHISs with the Belize Health Information System (BHIS) as a model. Undoubtedly, the CARICOM countries that are not signatories to this resolution are also pursuing similar objectives. With the limitations of financial resources, manpower and time it is necessary that these investments are accomplished as seamlessly as possible and for maximum benefit. Therefore, the evaluative criteria that this study will provide are valuable. Moreover the importance of this study is not restricted to guidance for those with already implemented systems but also provides an approach to assess the progress of other systems under development and those in the pre-development stage.

The similarity in profiles among the regional countries in terms of governance, health systems management, financing structures and human resources management in addition to limited available resources provides an ideal position for relating an evaluative approach for any country within the region. Therefore, this work is useful for the regional efforts in the development of national iHISs.

1.2 STUDY OUTLINE

This paper addresses the aforementioned research objectives through utilization of the existing literature. The discourse covers five sections and a conclusion. In addition to outlining the rationale and expectations of this research, Chapter 1 begins the discussion

by providing an overview of the current HIS environment. A historical perspective traces the progress achieved in the development of HISs, while a look at the current events emphasizes the initiatives for developing national iHISs. The section concludes with a review of the BHIS as an example of the iHIS.

The second chapter details the concept of HIS evaluations. This perspective is used because of the infancy of the iHIS and the subsequent paucity in related literature. It elucidates the area of study by defining the terms of use and methods that are applied for evaluation purposes. This chapter provides the mechanisms for evaluating HISs, which will inform the strategy for evaluating iHISs.

Chapter 3 provides insight of frameworks that are applied for evaluating HISs. The components of these frameworks and their context of use are described. This section supports an understanding of evaluation frameworks and their role by describing the strengths and shortcomings of these frameworks.

In the formulation of an approach for evaluative activities, the context of these activities has to be examined. This is accomplished in Chapter 4 with a look at the background of HISs in developing countries and by extension those of the Caribbean region. The features of this context are presented with an emphasis on the major areas of effect. This section also includes a review of evaluations in this context to highlight areas of interest and best practices.

Chapter 5 presents the evaluative approach that is recommended for the Caribbean region. This content references the previously discussed areas in Chapters 1 to 4 and provides an evaluation tool CHEATS+ along with a set of recommended considerations for evaluating iHISs in this region.

This discourse concludes with a summation of the major themes and the implications for this study and its recommendations.

1.3 HEALTH INFORMATION SYSTEMS

1.3.1 A HISTORICAL POINT OF VIEW

The terms ‘health information system,’ ‘healthcare information system’ and ‘healthcare information system’ are used interchangeably. No differentiating factors have been established to indicate a difference in terms of reference. However, an understanding of the terms of reference is very dependent on the context of use. The context varies by scale and is influenced by the goals of its application.

Earlier references to this type of infostructure referred to the computer-based medical IS. The composition of subsystems included administrative IS, clinical IS and clinical support systems that were connected and were comprised of their own subsystems [6]. The goal of the medical IS was to apply technology to collect, store, process, retrieve and communicate patient information to support patient care and health services [6]. Much of this earlier development focused on the management of patient administrative and financial data.

Lindberg’s theory [6] (see figure: 1) presented in 1979 on determining the functional requirements of these systems supports the principle of contextualized use. This concept is still relevant and can be used at present to establish the functional scope of a system and enable an understanding of the areas of application. Also relevant is the 1985 expression of what can be described as the vision for medical information systems. It is a forecast that included the computer-processable longitudinal patient record with the

ability to incorporate evidence from medical knowledge sources [6]. This is the goal for many HISs today, especially for national initiatives.

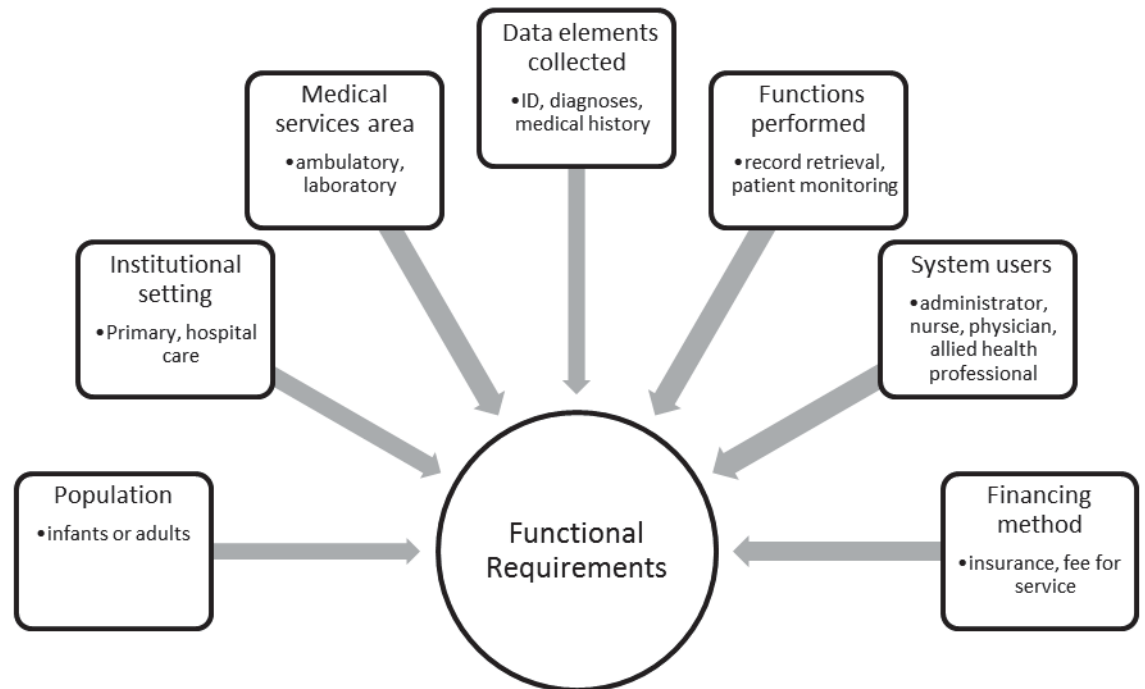


Figure 1 Lindberg's theory on system functionality
Adapted from [6]

Over the last four decades the advances in healthcare IS have extended from use of centralized administrative and financial IS at larger institutions to the current applications including electronic health records, decision support, computerized provider order entry, and medication administration [2]. If the transitional path defined by Haux [7] is applied to describe the progress, it will imply a migration from hospital IS to regional HISs and extend to what is described as transinstitutional HISs. The HIS structure has been extended with scaling-up and each progression involves extensions in context and functionality.

There are some notable limitations of these earlier large-scale systems. Among these limitations are the restricted operation within the public sector, non-integrated independent systems with redundant data capture and lack of feedback to service providers [8].

The HIS architecture has evolved from specific medical IS to larger scaled systems today. This expansion has been seen in the aspects of geographical range, use and functionalities and platform types. However, the historical model of system functionality can be applied today for describing and classifying HISs.

1.3.2 A CURRENT PERSPECTIVE: PRINCIPLES AND INFLUENCES

The current emphasis for HIS is achieving integration. This migration of focus can be seen in later descriptions which adopt the principles of the following definition: “Health information systems integrate data collection, processing, reporting, and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of service” [9]. While this highlights an integration of processes, the emphasis is also on integrating healthcare data and supporting management functions.

This emphasis on supporting management functions causes the HIS to be equated to IS within other sectors. In one case the definition of HISs is derived by applying the description of IS with an attached reference to the healthcare sector [10]. The summary of this definition represents a computer-based IS utilized in healthcare settings. While there are existing similarities between HIS and IS utilized in other sectors, there is a limitation in this type of definition. This definition does not consider the complexity of healthcare

and the degree of the integration required in this context. While the labels may be similar, the applications and their connections are very dissimilar and present a unique challenge in integration.

This emphasis on management functions has also given rise to use of the term ‘health management information systems’ in reference to the HIS. This is not an accurate representation and represents a limited scope. A better representation can be achieved through an understanding that the health management information system refers to a subsystem of the HIS [9]. Its role is primarily to enable processing of information for administrative management purposes and does not include patient treatment records.

Supporting patient-centric care is a principle for HISs [7]. This has evolved along with the principles and practices of health informatics. In addressing these priorities HISs have begun to highlight the roles of the individuals involved in the healthcare processes; creating an environment that focuses on the participating actors. Therefore, to describe the HIS currently, the roles of the actors in provision of better care should be used [9]. This role-based approach targets process improvement for all actors and can include improvement in workflow processes or better data handling, etc. The contribution of all actors to the efficiency of the system is important and points to the design of HISs as a configuration of encounter-based procedures. With this encounter-based method each activity involving the system is engineered to optimize patient care and resources utilization. This approach is used in the Belize Health Information System (BHIS), currently described as an example of an iHIS [8, 11, 12].

More contemporary thinking uses the health ecosystem concept for describing the applications for health informatics. This point of view captures the organizations, service

areas and functions within the healthcare sector and considers the contribution of all entities to the healthcare process. It demonstrates the wide range of participants and advocates for an integrated approach to connect and support all entities. This ‘systems thinking’ description aptly defines the vision for national HISs, which we will examine later. This point of view coupled with the movement towards the ‘healthcare enterprise’ and Enterprise Resource Planning (ERP) systems are fuelling the need for integration.

Much of the discussion about HISs focuses on the computerized HIS. However, as is the case particularly in developing countries, a manual system comprised of paper records could be operational. The simple to complex implementations can range from “pencils and paper” to “fully integrated, web-connected” technological tools [13]. The value of an IS to the health sector should not be based on assumptions about automation but rather on the demonstration of efficiency and performance [8]. A well-designed paper-based system is very capable of providing adequate results [14]. Therefore, the added value of computerized HISs has to be found in how they contribute to the quality of the health system. A plethora of computerized stand-alone systems, for example, does not add to the strength of the national health information infrastructure. This can actually be a challenging environment for health workers as demonstrated in the Peruvian experience [8].

The potential value of utilizing information and communications technology (ICT) for HISs includes: enhancement in the availability, dissemination and use of health related data, improvement in the amount and quality of data collected and an improvement in timeliness, analysis and use of information [13]. These technology outcomes, however, are not guarantees of health related improvements. The balanced

outlook to enable useful adoption of ICT in healthcare is maintained by an acknowledgement that technological tools are to support the provision of care and by the recognition that information technology is the enabler.

HISs are implemented to foster improvements in data-related as well as management processes. While the emphasis is on information management, there is also a considerable influence from an aspiration to positively impact the patient care delivery process. As a result, while technology has been important and its benefits acknowledged, it has not been the central theme.

1.4 THE NATIONAL INTEGRATED HEALTH INFORMATION SYSTEM

1.4.1 IHIS COMPONENTS

The need for integration is not novel to healthcare IS; rather it is expressed as relevant for IS in areas of business and government as well [15]. Providing data to support decision-making at all levels is an underlying theme of the integrated healthcare IS. The components of the iHIS can be varied; it depends largely on the existing infostructures and is determined by each country. The World Health Organization (WHO) model [11] emphasizes the contribution of existing national data sources such as the national statistics bureaus and civil registries. The aim is to facilitate the collection of health related data from population and institutional sources.

While this recommendation portrays a universal view of national data sources it is also a reflection of the WHO's responsibilities of data collection. The illustration of this concept (see figure: 2) demonstrates an emphasis on data collection.

Data collection has to be supported by an understanding of how these national data sets of population and institutional data intertwine and relate to each other. The underlying data connections are of importance because if this method is applied effectively it can support validation and data reliability. The strategy to realize this would require rigorous data pooling practices to benefit from the potentially rich data that will be collected.



Figure 2 National iHIS data sources
Adapted from [11]

The electronic patient record is viewed as the central component of the iHIS structure [15]. Therefore, much of the development activities have centered on the implementation of the patient health record component. This can be described as an integration effort in itself, when the existing health systems are considered. This is a task that requires the amalgamation of multiple systems within the health sector, whether they are at the

institutional level, disease specific, built on diverse software platforms or geographically separated. Interoperability is proffered as the approach to achieving the integrated electronic patient health record. These two subjects are addressed in the Health Metrics Network framework, which advocates for an integrated system achieved by interoperable components [16].

These subsystems of HISs are described as [9]:

- Disease surveillance
- Service reporting for basic health services
- Specialized services reporting
- Administrative systems and
- Civil registration systems.

The components of the iHIS have to be examined on both the institutional and population level. The population approach requires integration of national data sources. At the institutional level, the electronic patient record requires integration of multiple health sector services.

1.4.2 ACHIEVING INTEGRATION

Implementing the iHIS is the goal for health information management for many countries. It is sought to provide a consolidated approach for healthcare and to combat some of the common weaknesses in HISs. Some of these weaknesses include data collection activities that do not produce useful information; redundancy in data collection, processing and reporting among systems; the inability to access current data; and the collection of incomplete or inconsistent data [9].

Varying architecture models are applied to achieve this objective of integration. Some approaches utilize methods for connecting existing infrastructures, while others prefer to implement a single architecture. For smaller scale uses the single architecture approach can be utilized but this becomes challenging with increasing scale where the number of nodes increases exponentially and the application platforms are varied.

One of the articulated views relates to the connection of existing systems. It is thought that in circumstances where there are multiple systems with their accompanying data duplication, a single system is required for resolution [9]. It is thought that such cases cannot be solved by strategies to promote sharing and collaboration among programs [9]. This view is motivated by the challenges encountered when attempting integration in an environment with parallel or multiple systems. It is often difficult to find resolution when combining policies and organizational processes among these programs. The challenge of finding resolution in these cases is understandable; however, the single system configuration may be too simplistic and not fit all cases. In those instances when the single system configuration does not fit middleware connectivity may be a better solution for information exchange. The use of a standard for connectivity is proposed to enable “robust, independent components that communicate through well-defined interfaces” [15]. This can address the challenge of multiple non-compatible systems that are operating in some countries.

One of the main features of the iHIS is the information sharing capability. This can be described as the reality where “elements of a patient’s health record are accessible across different regions and to all authorized providers, with the ability to send messages (like reports and discharge summaries) across the system securely” [17]. The main goal is

to enable access to the electronic health record by providers to support patient care. The strategies for achieving this goal include having a single, centrally-stored electronic patient record to which providers can add or read, as in Belize; or allowing providers to view patient data through regional systems as in the United States proposed implementation.

There is not enough evidence to determine the best option for any environment. The examples do not provide sufficient variation to enable a conclusion on the best approach that should be applied in various contexts. If the locations are identical then a limited generalization can be made. Further both of these approaches present challenges in adaptability, interoperability and costs [17] that also need to be considered. To determine the suitable approach would require an examination of the relevant features and decision-making based on the similarities and dissimilarities in context. Ultimately the decision lies with each country as to the preferred approach.

Canada's infrastructure, for example, is built on a mechanism for national connectivity and sharing of electronic health records. Its model is a blend of both centralized and distributed architecture; with the Health Information Access Layer (HIAL) providing the connection for loosely coupled components [18]. While Australia uses a similar strategy, the United Kingdom and France have utilized central data repositories [18]. Other initiatives in Germany, Taiwan and Brazil have utilized the smart card technology. The Taiwanese territory-wide (over 22 million) smart card system is deployed through its national health insurance agency with data uploads after six transactions [19].

Canada has invested to operationalize its health information sharing goals for the provinces and appears confident that its model will yield success for integration. The sentiments echoing across its southern border, in the United States, are different. While noting the importance of a national infostructure to support healthcare processes, it is advised that local level health information exchange should be adopted as the better alternative. The magnitude of investments in time, technical skill and financing needed to produce one iHIS; the lack of support for sharing across organizations; along with the concerns of privacy and security are noted as barriers to this single information exchange infrastructure in the United States [20]. This is an example of the bottom-up approach with the potential of connecting the regional hubs to a national infrastructure [17].

All of these approaches to integration are predicated on the need for a single, shared record which may not be feasible or necessary [17]. One argument against the single record architecture points to consideration of the actual number of patients that move from one geographical region of a country to another and the frequency of these relocations. It is thought that these events are not frequent enough to merit the investment for establishing single, shared patient records [17].

Achieving integration requires synchronization on the technical level. This includes integrating multiple data sources, ensuring data standards and maintaining the consistency of the system in terms of not only data but in availability, access and management [7]. To this list of requirements must be added the synchronization of healthcare entities. This is an important acknowledgement as success hinges upon a merger of not only data sets but also of priorities and decision-making [21]. This political

process that accompanies the negotiation of a shared system is critical and influences its adoption and use [16].

The attempts to achieve iHISs in developing countries such as Tanzania have been documented [21, 22]. The Tanzanian experience has convinced researchers that successfully implemented systems would be the result of a fusion of perspectives [21]. This blending of viewpoints will include considerations of not only information management but also developmental attitudes, social constructs, management approaches and epidemiological knowledge [21]. Successful integration allows local entities to adapt and contextualize the standards to meet their needs.[21] To achieve these states of integration the healthcare sector has to be considered as a whole, including the environmental factors and influences.

This view of the healthcare sector often extends beyond the locale of the healthcare institutions and can include agencies outside of the physical borders. This is the reason that the role of politics at the international, national, and institutional levels has to be considered in the creation of an iHIS [16, 21, 23]. Political stakeholders whether local or overseas by their involvement can either aid or hinder the integration process. Therefore, understanding the effect of their actions will be informative for implementers. Political stakeholders are also usually the authorities to endorse or deny integration initiatives.

It is clear that these non-technical factors are significant and will influence the achievement of integration. While there are essential components that are present in all HISs, the socioeconomic, political and administrative elements will influence the design for each country [9] and ultimately determine whether each country meets the goal of integration. The functionalities of existing HIS are today largely influenced by

governmental and institutional priorities. This is especially evident in developing country systems and highlights the role of political input in the development of HIS in developing countries.

This is the reason that it is challenging to utilize the recommendations of bottom-up or middle-out approaches in addressing developing countries. In developing countries the provision of health related services is largely public and government provided. Reducing the government's role to policy development may result in an environment where the vulnerable are neglected in care. Therefore the 'hands-off' method may not be the justified direction for governments of developing countries. The solution however may be in an approach that includes governmental direction but outsourcing of the development activities. This was the method applied in the development of the BHIS.

It is evident from these discussions that achieving the national iHIS is not a simple objective. Its solution is not in duplicating a clinical system at health institutions across the country [17]. The combination of people, processes and technologies requires that efforts towards integration include considerations of each component. It requires attention to political roles, standards compliance, scalability and local context. Anything less would render an incomplete solution.

Integration is a strategic issue. It involves the fusion of policies, perspectives, infrastructure and stakeholders. One of the primary aims of integration is to enable information sharing. The methods to accomplish this vary across countries. This has prompted discussions about the role of governments in enabling integration. What is not debatable, however, is that governments have a role to play in enabling integration whether it is through policymaking, funding, legislation or standards-development.

1.4.3 INTEGRATION: THE BHIS EXAMPLE

The BHIS has been presented as a model achievement for national iHISs [8, 11, 12]. The BHIS began as a result of a 1999 Health Sector Reform Project supported by the Inter-American Development Bank. This project was funded by the Inter-American Development Bank (IADB) and the CDB with technical support from the Pan-American Health Organization (PAHO) and Accesstec. A chronological summary of the system's development (see figure: 3) shows the progressive expansion and growth in technological applications.

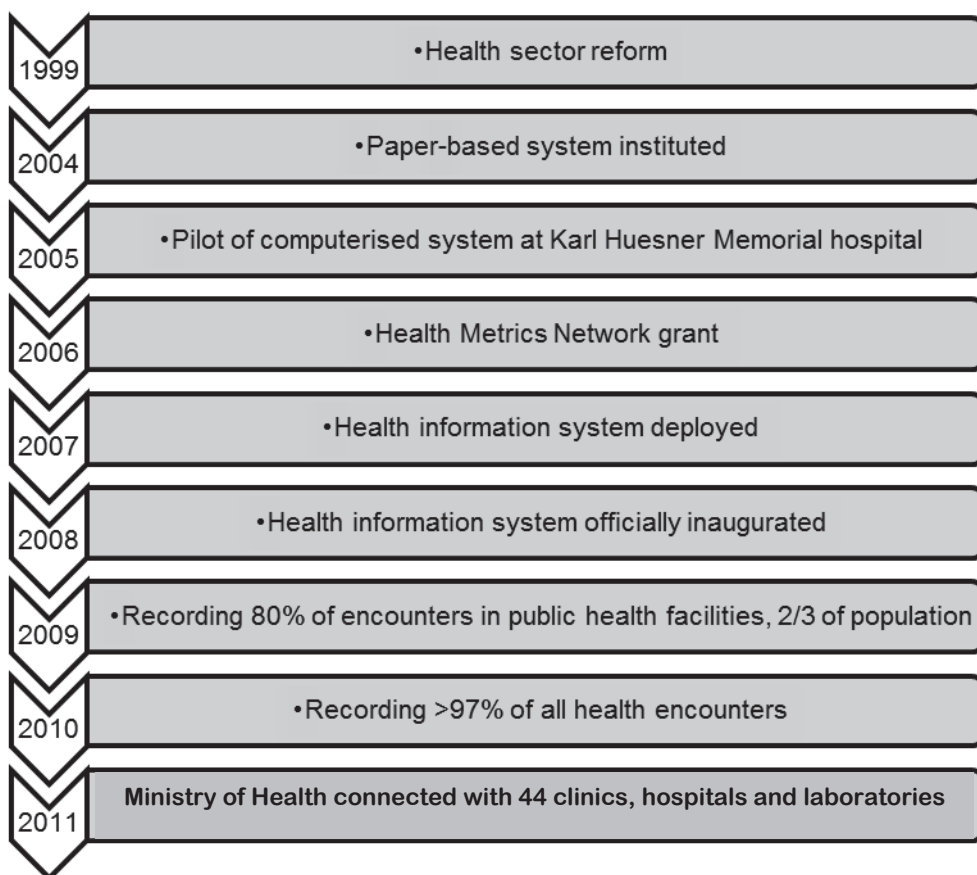


Figure 3 BHIS development

The operational features of this national iHIS are summarized as:

- web-based, portable electronic health records
- countrywide authorized provider access with role-based information delivery
- clinical information exchange
- management reporting and alerts and reminders to decision makers
- disease tracking and monitoring
- support of health programs (e.g. HIV)
- patient medical history with longitudinal lifetime record
- ICD-10 coding standards
- supply chain management
- national data warehouse or repository

Outcomes, performance and utilization were identified as the areas that this system would support [24]. The focus was on improving the health profiles of individuals, driving better performance in the public health sector and enabling better utilization of health sector resources [24]. Health outcomes, operational efficiency and cost effectiveness are meaningful measures to indicate the value of this system [T. Rutter, Personal communication, 25 Aug. 2011]. The gains in these and other areas have been deduced for generalization to other countries within the Caribbean region. It is proposed that the benefits will include financial savings, reduction in adverse drug reactions and improvement in health interventions such as maternal HIV transmission, hypertension and diabetes [25]. Gains in individual and population health for Belize include the reduced maternal-child transmission of HIV rate from 40% to 5% and 25% reduction in hospitalizations in hypertension cases over age 65 [25]. In terms of overall health a reduction in all causes mortality rate is forecast.

Integration within the BHIS was implemented on a patient level and on a population level. A patient record info-structure that includes multiple functionalities is used to manage the health related data of individuals and at an aggregate level for institutions. The understanding that patient and population health are intertwined is a principle in the system's development [24]. Therefore while these components are sometimes described as modules implying a separation and boundaries, they are really interconnected and are not standalone components. Identifying these components as functionalities would be a better description [T. Rutter, Personal communication, 25 Aug. 2011]. Similarly the use of the term 'subsystem' while conceptually useful, if replaced with the term 'functionality' provides a more accurate description of the actual implementation of the BHIS. The functionalities that are incorporated are described as [24]:

- Electronic Health Record and Admission Discharge Transfer - these are the central functions comprising the longitudinal record that captures patient demographic and health service data.
- Clinical Order Entry – coupled with the Electronic Health Record and Admission Discharge Transfer function, this e-prescribing functionality manages the prescribing and dispensing activities.
- Medical Laboratory and Testing – enables the ordering, recording and publishing of images, vital signs and tests.
- Financial – provides encounter-based costing.
- Maternal Child Health – the capture of data about pregnancies and deliveries; this enables monitoring for high-risk pregnancies.
- HIV/ AIDS – records data to support HIV/AIDS monitoring and treatment.

- Supply Chain Management and Inventory Control – coupled with the Clinical Ordering Function allows inventory tracking at all facilities.
- Public Health – records data on public and community health factors; gives the ability to assess community health through disease and events tracking.
- Human Resource – supports human resources functions including staff scheduling, training requirements tracking and performance evaluations; provides information on health sector employment and employees.

With the encounter-based recording method each encounter provides the details of a provider’s interaction with the patient. During system use, navigation to each encounter is accessed from the patient node. [T. Rutter, Personal communication, 25 Aug. 2011]. This collection of encounters creates the longitudinal patient record, (see figure: 4).

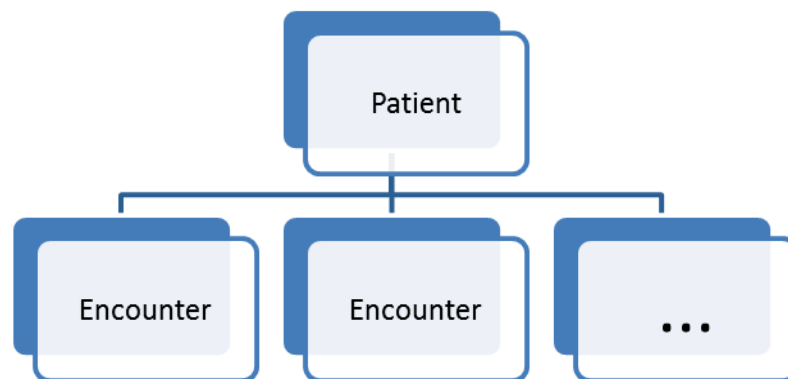


Figure 4 Longitudinal patient record model for BHIS

The available encounter types include:

- Vital Statistics: Births and Deaths
- Hospital Admissions
- Outpatient Clinic Visits
- Emergency Services

- Pharmacy
- Clinical Laboratory
- Radiology

The integration of the system with population sources requires connections with external sources to facilitate data exchange. The means for achieving this national amalgamation, based on the Belizean strategy, will require enabling at least six connections or external data flows. These flows exist between the local nodes and population sources such as Social Security and Vital Registrations. There are additional flows between the national repository, national statistics sources and health reporting entity.

While there may be relief in not having to negotiate interoperability across medical facilities and functional subsystems of the BHIS, the implementation of the BHIS as a single-platform system has attracted some disapproval. It is thought that the single system, single-platform approach would limit the system's ability for scaling and utilizing functionalities from different platforms. It is thought that the creation of a national iHIS by integrating the solutions of vendors specialized to each healthcare area would enable a best of breed approach and result in more robust systems [R. Hebert, Personal communication, 15 Feb. 2011].

The best of breed approach requires enactment of interoperability standards for connections among systems. In some cases the use of proprietary components by vendors restricts the ability to integrate the electronic components. Interoperability among vendor systems is an ongoing discussion with no specified standards for all systems. The lack of

resolution in this area raises questions for decision makers about the results that they will achieve with the best of breed approach.

The level of customization in subsequent implementations within the region is also presented as a concern. The local solutions are predicted to be dissimilar, eliminating the ability of countries to reach out to each other for support when difficulties arise [R. Hebert, Personal communication, 15 Feb. 2011]. Local implementations are developed to support the existing national policies and workflows. It could be countered that customization is useful and necessary because of the contextual differences imposed by national boundaries. This would justify the need for customization in regional implementations.

The challenges to achieving the national iHIS have been addressed by different approaches across countries. It is clear that the evidence of an operational system which is achieving results is more influential for decision-makers. Demonstrating the success of the alternatives would be helpful to convince decision-makers of their value.

The BHIS has enabled the Belizean Ministry of Health to effect programs and procedures that yield benefits for the local health system. The values of improved outcomes, performance and utilization are useful for other national iHISs. The integration model relies on coupling of functionalities and connection of data sources. Evidence of benefits can influence the use of specific approaches, so a deliberation of the pros and cons for each country will determine the implementation model.

1.5 SUMMARY TO CHAPTER 1 AND TRANSITION TO CHAPTER 2

This section presented the rationale for undertaking this study of evaluations for national HISs. To support an understanding of the content to be examined, a view of the current influences of HISs was provided, along with a historical perspective. Because the iHIS is the current focus of these implementations, an in-depth look at the components and functionalities was taken. It was useful to examine the methods that are being used to achieve the iHIS. Further a case was examined through the description of the regional example, the BHIS. The discussion will continue to a review of the elements of evaluations for HISs.

CHAPTER 2 EVALUATION OF HEALTH INFORMATION SYSTEMS

2.1 OVERVIEW

This section provides the theoretical premises for conducting evaluations of HISs. In this section the methods for performing evaluations are addressed. The discussions begin with an explanation of the term and then outline the value of evaluations. The methods for performing evaluations are described in the subsections of what, when and how to evaluate. The aim of this section is to discover the principles for evaluating HISs.

2.2 DEFINITION

The term evaluation is generally understood to be a process of measuring. The approaches to the act of measurement are numerous and are tailored to the context of use. Although the act of evaluation is complex and wide-ranging, the succinct expression describing an evaluation as: “the decisive assessment of defined objects, based on a set of criteria, to solve a given problem,” [26] gives an accurate depiction of methods, parameters and outcomes. All of these are associated with the process of measurement.

Another relevant description notes that an evaluation is the process of describing the implementation of an information resource and judging its merit and worth [27]. The reason for an evaluation is also important to its definition. An evaluation has no value in itself; it is performed in the context of informing a decision [28]. At the end of an evaluation, information from a selected perspective is made available for decision-making [29].

It is important to frame the context of the evaluation. This determines whether the activity is judged as an evaluation or a research project. The distinctive attribute is the

influence of stakeholders in the process [30]. This in no way diminishes the rigor and principles necessary for the evaluative activity. This “systematic application of social sciences research procedures,” [27] requires adherence to the guiding principles of good research; being “grounded in scientific theory and rigorous approaches” [31].

There are two trends in the evaluation of HISs; one being the shift in focus from technical to human and organizational issues and the other being the use of the qualitative approach [10].

The emphasis of research and evaluation activities can be [30]:

- The external environment of the organisation
- The internal environment
- The IS users
- Systems development environment and staff
- Management and operational environment of the system
- Nature of the system including information processed
- Patterns of utilization
- Organizational impacts: direct or indirect, intended or unintended
- Social impacts: direct or indirect, intended or unintended

This does not represent an exhaustive list as evaluation activities can be performed to address any areas of interest that are presented. The deciding factor in performing evaluations would be its worth in providing the answers being sought.

An evaluation is an activity whose intent is to provide answers that can be used to inform decisions. Therefore, the reason for an evaluation is important to its description. The presence of stakeholders is a defining characteristic of evaluations but does not

diminish the activity's emphasis on research-related and scientific approaches. The evaluation of HISs is being influenced by the use of qualitative methods and an interest in human and organizational issues.

2.2.1 PURPOSE

The realization that robust technology does not guarantee a successful implementation gives impetus for evaluation activities in health informatics. It is known that “the most innovative technologies carry no guarantees of successful implementation or productive use by diverse populations of users” [32]. Evaluations provide a mechanism for judging the success or failure of these implementations. One of the overarching aims of evaluations is to enable identification of the factors that contribute to the success of the implemented system [33].

The role of evaluations in the future development of HISs is well-known. Among its goals, evaluations enable an examination of the system's performance, safety and effectiveness while improving quality of care and cost-effectiveness [10]. Evaluations are also useful for providing lessons to inform future actions [10]. Providing this evidence is critical to validating the benefits that are often advertised. To provide evidence of benefits in health information technology utilization there should be an account which includes cost, return on investment, critical success factors and alternative explanations for the successes [34]. These would become examples for future activities [34]. In the absence of such evidence the authenticity of the supposed benefits must be questioned [35].

In the health informatics setting the objects of assessment are quality, value, effects and impacts, for an outcome that enables improvement and evidence based practice [29]. With the perspective of assessing IS effectiveness, evaluating information quality should be an essential focus of evaluation activities [36]. However, examples show that evaluations of health IT applications are often not identified as a part of the strategic plan for implementation, [37] and are oftentimes overlooked.

Evaluations are informative for the future implementations of HISs. They are the source of evidence to validate the promised benefits and determine the factors influencing success. By examining performance, effectiveness, cost, return on investment, quality and impacts evaluations of HISs confirm whether the system has failed or succeeded. However, the knowledge that evaluations provide evidence does not always influence practice as evaluative activities are often not included in implementation plans.

2.2.2 CHALLENGES

The complexity that accompanies evaluations makes them prone to challenges in several areas. Protti [33] in addressing the challenge of performing a comparison among ten countries noted the difficulty in acquiring reliable data because of the lack of a central coordinating agency within the countries [33]. This is common with the decentralized nature of current health systems.

Other challenges that have been identified are:

- The complication posed by the need to consider the system's context in terms of the organization (workflows and processes), people (behavior and attitudes) as well as temporal details [26]. These are necessary for validating the quality of the

assessment [26]. The actual process of conducting evaluations is affected by environmental influences such as the social, cultural and political context as well as the available resources and logistical challenges [38].

- Getting support from all stakeholders including the funding agencies can be a daunting task. Evaluation activity can sometimes be perceived as a campaign to identify deficiencies that will reveal unpleasant details about the system. Because of this it is valued as a less important concern [26].

The difficulties encountered during the evaluation of two large-scale implementations can be applicable to this context as well. Those challenges identified from practice include [38]:

- Randomized control trials are not always possible
- Unclear objectives for the evaluation because of multiple stakeholder interests
- Difficulty in determining the most valuable aspects for examination
- Difficulty in generalizing results of cost-benefits analysis
- Absence of baseline data for comparisons
- Combining the different approaches from investigators and research methodologies
- The short period of time available to thoroughly understand the project before developing an assessment plan and
- The persistently changing focus for areas of evaluation

The challenges accompanying the performance of evaluations are numerous. This indicates that performing evaluations requires the ability to adapt to the circumstances.

As such, evaluations require management of technical, human and environmental factors to enable the best possible assessment in the given conditions.

2.3 METHODS FOR EVALUATIVE INQUIRY

Evaluation theories, in general, are grounded in accountability and social inquiry, but primarily the latter [39]. Accountability provides the motivation for evaluations by asking questions about responsibility while social inquiry provides the means for accomplishing the evaluation [39]. The theories for evaluation research can be identified as being concerned with use, methods, or assessing value [39]. Theories based on the principles of use focus on the use and users of the evaluation results. There is an interest in the contribution of the evaluation to decision-making [39]. The methods theory emphasizes the role of evaluations as a research activity. This focus promotes the use of evaluations for constructing knowledge [39]. The emphasis is on the correct application of research methods [39]. The value-based theories are concerned with the role of the evaluator as the authority on the importance of the results [39]. This latter theory has been extended to include the role of other stakeholders in judging the importance of the evaluation results [39]. In each of these areas of theory there are several evaluation perspectives.

For HISs the design used for evaluation studies has been largely unchanged over the years. A historical example reveals that the dependent variable is identified as quality measures of system processes and the system components are the independent variable with the contextual background determined by the social, political and economic factors [6].

2.3.1 WHEN TO EVALUATE

The evaluative practice should begin prior to implementation and be supported for an extended period which includes the duration of deployment and in operations [26]. The time period when an evaluation is done influences the inquiries as well as the assumptions of the evaluation. Therefore in deciding when it is best to evaluate, an approach that combines formative and summative evaluations of HISs is recommended [40]. It is noted that assessments should be integrated into the process as technologies are implemented [40].

Summative evaluations provide an assessment of a completed implementation, while the formative evaluation represents a progressive appraisal during the implementation process. These approaches may seem to be contradictory in use but actually they are complementary to each other. Therein lies support for the utilization of both approaches. Because of its retrospective view, the summative evaluation needs to address how well a system meets the requirements initially used to motivate its implementation [41]. This type of evaluation can include a reflective exercise [41] to provide answers.

Evaluations should be planned for the duration of the implementation process. The formative and summative evaluation approaches provide answers to different inquiries. Therefore both are useful for the evaluation of HISs. The formative evaluation provides an assessment of the implementation as it progresses while the summative evaluation focuses on the end product, to demonstrate whether the goals of the implementation were met.

2.3.2 WHAT TO EVALUATE

The prior assumptions inform the perspective of the investigator and hence the questions that will be generated from that perspective. These initial assumptions and the stakeholders' goals for the evaluation [30] are significant influences for the object and content for evaluation.

In determining whether implementations of ICT in healthcare are providing value, the technology as well as the people and the environment are valuable components of an assessment. An evaluation of technological components is limited in assessing the impact of HISs because it limits the consideration of social and organizational factors [42]. This suggests that the technologies must be evaluated in the context of an entire system [29]. The design of an evaluation should be guided by a review of technical, social and organizational factors to determine what should be measured and how it should be measured [37]. In evaluating a system's effectiveness the emphasis should not be limited to examining how well the system performs but should include an assessment of the system's performance within a particular context in terms of users and the environment of use [10]. The evaluation exercise should not be focused on proving generalized benefits of HISs but instead should consider the context and its impact within the local environment [41].

The complexities of the HIS functions can be assessed by conducting a detailed evaluation on each unit [41]. Considering that there are several factors to be addressed in an evaluation, it is noted that the application of weighted measures to the factors can provide a valuable generalized view of an entire system [41]. However, when a system

has components that are highly coupled, using the strategy of weights and rating is not recommended [28].

The emphasis should be on utilizing approaches that have been verified. Additionally, the measures and success indicators that are used will be influenced by the objectives and context of the research inquiry [36]. These can be determined by priorities and perceived importance.

While economic evaluators focus on an analysis of the expenditures and benefits of a system, sometimes the intangible benefits are not considered. As a result, the measurement of the non-quantifiable outcomes such as “postponing disability and death” and “improved care and quality of life” has eluded some evaluations [6]. Accounting for these accompanying benefits increases the difficulty of the evaluation activity.

The evaluation of HISs has to consider the technical as well as the non-technical factors. Social and organizational features are also influential to the system’s performance and as a result their role has to be examined. The evaluator and stakeholders contribute their assumptions and interests to an evaluation and this also affects the focus of the evaluation. The focus of an evaluation is further influenced by the national context as priorities may vary from country to country.

2.3.3 HOW TO EVALUATE

HIS evaluation needs the strength of both the qualitative and quantitative methods [43]. Both types of methods should be applied as each brings the evaluative capacity for different aspects. The system’s environment (social and organizational factors) legitimizes the integration of qualitative approaches to HIS evaluations [38]. The

qualitative methods look at what makes the system work and not simply reporting the results of the system's work. They aim to provide a better understanding of the state of affairs by examining the system in its environment [44]. However, when qualitative methods are used for evaluative purposes there is an amount of subjectivity that cannot be censored [41]. In qualitative research it is necessary for the researcher to provide insights to the setting [41] and the assumptions of the researcher and the users will influence this description.

The use of quantitative methods is advocated for settings where the elements of the system are static and without connections. These elements can be technological, organizational, individual users or requirements for information [44]. The quantitative methods are focused on providing discrete answers without demonstrating the impact of the context.

Both quantitative and qualitative methods should be applied in the evaluation of HISs. The usefulness of each type of method in addressing evaluation areas supports this recommendation.

2.4 APPLYING EVALUATION METHODS

The methods applied to evaluating HISs have included randomized control trials, surveys, observational studies, usability testing and cost benefit analysis. The methods applied are related to the questions being answered and are also dependent on the phase of the implementation. There are no clearly defined methods that are prescribed for specific phases and inquiries. The methods used are influenced by the researchers' understanding of the object under review and the method thought to be ideal for the

purpose. The number of available methods is not reflected in practice, in part, because of a lack of knowledge among researchers [31].

The views of researchers on methods for evaluating national HISs highlight the absence of gold standards in evaluation approaches. For instance, it is suggested that in performing a country-wide evaluation a randomized control trial should be used [41]. In this case because the variables are numerous it is difficult to measure the effects of the system through a simple before-and-after study [41]. However, it is noted that for highly coupled systems, the qualitative approach is more suitable [28]. Country-wide systems such as the BHIS are highly coupled systems. Additionally, the challenges of performing large system evaluations that were identified by Heathfield are also factors that consequently make the use of experimental methodologies impractical [45]. In a setting where the evaluation focuses on implementation of health IT in smaller practices, it is suggested that alternatives to the randomized control trial could be successfully used for achieving similar research outcomes [37].

The methods used at different phases can also be different. In describing a formative assessment, the methods noted as applicable for this type of inquiry include systematic literature reviews, focus groups, interview, surveys, observational studies, document review and formal-use case analysis [32]. In the evaluation of system components, assessment of the modules individually is the goal. This can be accomplished through scenarios or case study methods [32]. When the system components are evaluated as an integrated unit this can be done in a setting that replicates the anticipated system environment [32]. This enables observation of how the system works and provides an

assessment of whether it has met the predetermined requirements [32]. This gives a summative evaluation report.

Usability testing approaches that focus on both the system's usability and the users' productivity can be applied [32]. The methods for testing in the proposed setting can be either quantitative or qualitative; field observation, think aloud methods and analysis of system logs are methods that can be used at this stage [32]. When a system has been deployed, the evaluation provides insight into how well the system has met the proposed goals for its implementation and the factors that enable it to meet those goals [32]. Either quantitative and qualitative methods or a mixed methods approach can be applied at this stage with techniques including randomized control trial, cost-benefit analysis, critical incident technique and focus groups [32].

The MEM, Multi-method evaluation model, uses a similar approach with a mix of methodologies and methods. In utilizing MEM the evaluative dimensions are based on the choice of method to be used [10]. This approach was designed to be conducted over a number of years [46] and would be useful for longitudinal studies of a system.

Another methodology utilizes the models of change approach to evaluation and uses ten questions as the starting point for evaluations that can sufficiently explore the assumptions brought by these change perspectives. The three models of change are 1) the computer as an external force, 2) system design determined by user information needs, and 3) complex social interactions as determinants of system use [30]. In operationalizing an evaluation based on this model, research methods for both quantitative and qualitative analysis are applied [30].

The multi-method approach utilized with both qualitative and quantitative methods provides the mechanism for evaluating the changing priorities of a system during implementation. The usefulness of each method should be utilized to benefit the examination of the specific area under study.

2.5 ASSESSING MEASURES OF SUCCESS AND FAILURE

The success or failure of HISs is often examined as a measure of the system's value and usefulness. In some cases the system's ability to meet its proposed objectives is used as a measure of its success or failure. The variations in these objectives from one HIS project to another highlights the inability to specify universal measures of success and failure. In a review of 110 success factors and 27 failure criteria, all of the factors were found to be significant because of their relevance in one way or other [28]. In the absence of universal measures these factors can provide a reference point for evaluating the success or failure of systems. In evaluating HISs, the goal would be to reduce the chances of failure and increase the chances for success [31].

These success and failure factors extend beyond technical capability and include areas such political, social, organizational and management performance. It is known that technical factors are not the primary determinants of success or failure, factors associated with social or organizational features are much more influential in determining success or failure [31]. Therefore the inclusion of the non-technical factors enables a universal view of the system. This list is not exhaustive as other contributory factors have been identified in similar literature [31].

The satisfaction of stakeholders is also expressed as an indicator for assessing the success or failure of a system. It is noted that the stakeholders' contentment with the objectives that are met can point to the success of a system [47]. In one developing country study, success of a large-scale IS was assessed by measures of sustainability and stakeholders' responses [48].

The failures of HISs can be graded in terms of magnitude. The failures of HISs can be categorized as total, partial or sustainability failures [49]. Total failures represent systems that are never implemented or are implemented and not used; partial failures occur when a system meets only some of the goals for implementation and sustainability failures are those that meet the objectives but are not utilized for the long-term. To this set are also added replicability failures [49]. These are HISs that are introduced as pilots but are never deployed for use. The risk of failure of HISs increases with the magnitude of change effected by the new system [49]. These changes can be described as gaps: between a) the existing and designed systems and b) the design and deployment contexts [47].

Making the determination that an IS is a failure or success is accompanied by limitations. These limitations include the subjectivity and currency of evaluations [47]. A success or failure can be evaluated as such based on one's perspective [47]. This is evidence of the subjectivity in evaluation measures. The lack of evidence relating to a system over an extended period also limits the ability to describe failures or successes [47].

To assess success or failure factors the following methods, described in Table 1, can be utilized [31].

Categories	Focus Areas	Evaluation methods
Functional	Meeting the requirements and needs of users	Requirements assessment with framework for assessment of strategies; analysis of work procedures, stakeholder analysis, organizational readiness, future workshop
	Management of deliverables	Balanced scorecard, BIKVA, KUBI
	Fit of the system to the users	Usability, Cognitive assessment, cognitive walkthrough, heuristic evaluation, think aloud, analysis of work procedures, functionality assessment,
	Fit of the system to the organization	Analysis of work procedures
	Adaptability to change	Organizational readiness, balanced scorecard, risk assessment
	User motivation	Focus group interviews or Delphi along with social network analysis or stakeholder analysis
Organizational	Relationships within the organization	Social network analysis, stakeholder analysis
	Magnitude of resultant changes	Future workshop
	Inclusion for decision making	Focus group interviews (and social network analysis or stakeholder analysis)
	Workflow arrangements	Social network analysis
Behavioral	User participation and support	Stakeholder analysis, social network analysis, focus group interviews
	Management commitment	Situation analysis e.g. logical framework approach

Categories	Focus Areas	Evaluation methods
Cultural	Understanding of domain and organizational cultures	Analysis of work procedures
	Ability to accommodate a change in culture	Organizational readiness, field study, equity implementation model
Management	Adequate IT strategy, with clear goals	Balanced scorecard, framework for assessment of strategies, KUBI
	Benefits	Delphi
	Realistic expectations and plans	Interview, root causes analysis
	Understanding lessons from initial efforts	Functionality assessment
	Concessions for involvement	Risk assessment, logical framework approach, interviews, questionnaires
	Encouraging compromises	Balanced scorecard, KUBI
	Cohesion of enterprise ventures	Stakeholder analysis, social network analysis
	Managing stakeholders' interests	Stakeholder analysis, organizational readiness analysis
Technical	Technical quality	Technical verification,
	Usability	Cognitive assessment, cognitive walkthrough, heuristic evaluation, think aloud and video recording
Strategy	Suitability of strategies	Framework for assessment of strategies, interviews, focus group interview
Economy	Determining the return on investment	Delphi, impact assessment or field study
Education	Focus of training initiatives	Usability assessment, functionality assessment

Categories	Focus Areas	Evaluation methods
User Acceptance	User satisfaction	Questionnaires, user acceptance and satisfaction, equity implementation model, focus group interviews.

Table 1 Methods for assessing success and failure factors [31]

These are methods that can be used to address several areas in an evaluation. The same methods can be used to assess multiple factors. The most frequently recommended methods are stakeholder analysis, focus group interview, interview, social network analysis, and analysis of work procedures [31]. These methods represent both quantitative and qualitative approaches.

The success and failure factors provide a list of qualities that can be applied to evaluate the success or failure of a HIS from several operational standpoints. The methods applied for assessing these factors can be selected on their proficiency in providing answers about the area of focus. There is no lack of methods to address most of the areas of success or failure.

2.6 SUMMARY TO CHAPTER 2 AND TRANSITION TO CHAPTER 3

The role of evaluation activities has been examined and its importance underscored. The importance of evaluations as a complement to the development plans has been established, along with the importance of incorporating a non-technical emphasis. The assessment of success and failure was also examined. Their relevance and methods for

evaluating them were also presented. In the following section an examination of some of the frameworks which are utilized to assess HISs is accomplished.

CHAPTER 3 FRAMEWORKS FOR EVALUATION OF HEALTH INFORMATION SYSTEMS

3.1 OVERVIEW

This section provides a review of frameworks used to evaluate IS and HISs. The selection is intended to represent frameworks that can be applied for large-scale systems. The discussion highlights the focus of the frameworks, how they are applied and in some cases, their limitations. In the last section the assumptions about applying frameworks are presented.

3.2 UNDERSTANDING HEALTH INFORMATION SYSTEMS EVALUATION FRAMEWORKS

While the visual elements of a framework improve the ability to conceptualize and visualize it, the underlying theories of frameworks can be complex. Frameworks can be influenced by several disciplines and are demonstrative of a combination of perspectives to achieve an assessment goal. In health informatics, it is no different with health informatics frameworks being influenced by philosophical, social, behavioral, organizational and technical concepts.

3.2.1 DELONE & MCLEAN IS SUCCESS MODEL

According to Delone and McLean IS success is a “dependent variable” of research inquiries in this field [36]. In reviewing the origins of the model it is noted that a central component of the D&M IS success model is the 1949 framework proposal of Shannon and Weaver [36]. This outlook focuses on the syntactic and semantic quality of

information that is transmitted, along with its meaningfulness. This original work of Shannon and Weaver can be described as a general framework for assessing information processes, it emphasizes the value of communication and can be applied to any IS, computerized or not.

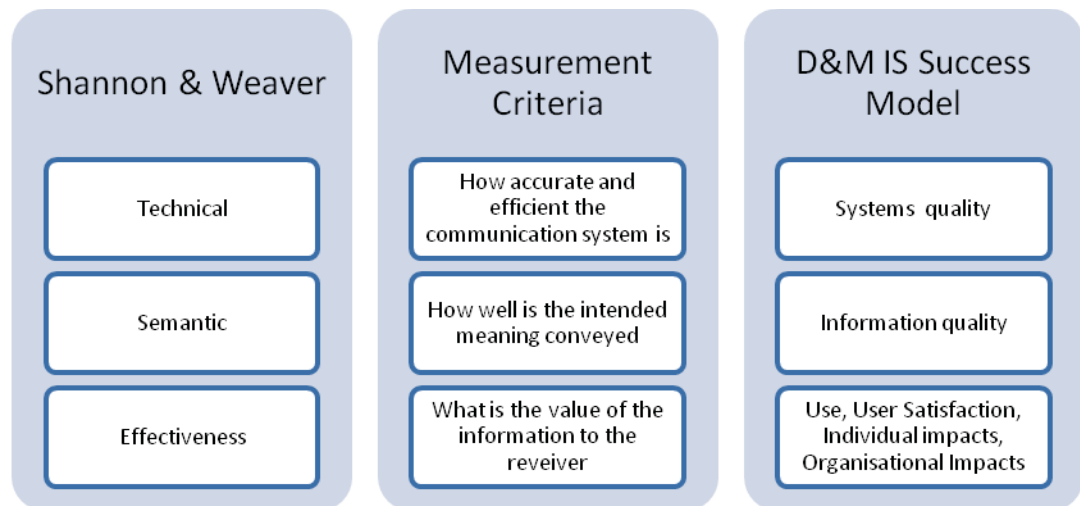


Figure 5 Alignment of the Shannon and Weaver and D&M IS Success Model [50]

The D&M IS Success model has been developed to fit the context of computerized IS but because of its relation to the Shannon and Weaver framework can also be used as a general IS framework. The adopted measures were aligned according to three measurement criteria, shown in Figure 5.

The application of this framework is strengthened by the relationships between the D&M model's dimensions. The D&M model provides an interconnection of components; between and within its dimensions. When using this model to effect an analysis of success an approach should be applied that validates the relationships between the model's characteristics [36]. This would provide insight not only of the entire system but aids in establishing the magnitude of the interdependencies and relationships among the model's constituents.

Numerous measurement instruments have been created to measure the D&M IS Success model dimensions and demonstrate the multi-dimensional composition of each of these characteristics [36]. The D&M IS Success model has been adopted and used with the measurement indicators described in Figure 6. There has been empirical validation of the associations between the model dimensions [26].

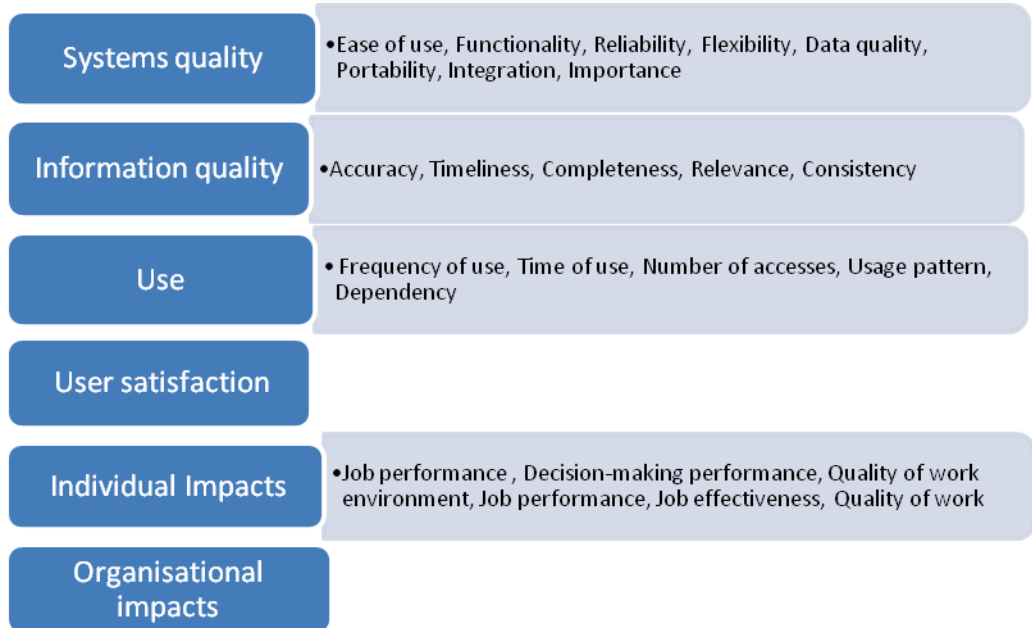


Figure 6 Components of the original D&M IS Success Model [36]

There were challenges to the initial D&M model [36]. These were rebutted and subsequently additions were made to the model. The additions that were deemed necessary include a service quality measurement and a combination of the impact measures to express net benefits of the system [36]. Net benefits would identify the effect of the system beyond the user and include the impact on any connected entities including the organization and the society. The model was subsequently updated to reflect these positions.

In practice, the mixed methodology approach can be applied to fulfill the data requirements of the D&M model [43]. In utilizing this method both the aims of the quantitative and qualitative approaches are met [43]. The weaknesses of this model are the lack of capacity to assess the contextual factors of an infostructure, [43] and an inadequate coverage of factors that are associated with failure [51].

A framework that incorporates the D&M IS Success Model and the Information Technology-Organizational Fit Model, the Human, Organization and Technology-fit (HOT-fit) evaluation framework, [42] was forged to enable evaluation of contextual factors. This blended framework provides sufficient context for HISs development by providing measurement dimensions that are found to be lacking in each other [42]. However, the proposed combination model of the D&M IS success model and the HOT-fit model does not retain the validity of the original models, in terms of its ability to assess the psychometric features [43].

The D&M IS Success model has been adapted and used extensively in evaluation of IS effectiveness [51, 52]. Its usefulness in measuring the success of e-commerce applications, [36] is promising for potential in assessing the effectiveness of web-enabled health applications.

The strength of the D&M IS Success model is in the relational connections among its components. The limitation of this model is its weakness in addressing the contextual factors. This limitation has prompted efforts to combine this model with other evaluation models.

3.2.2 CANADA HEALTH INFOWAY BENEFITS EVALUATION FRAMEWORK

The Benefits Evaluation Framework was developed based on the principles of the D&M IS Success model. It was adopted in 2007 to provide a model to guide evaluations for HIS projects in Canada. These projects were primarily sponsored through the Canada Health Infoway organisation. It is intended to provide insight about the achievement of goals relating to quality, access, and productivity. It employs the six dimensions of the D&M model with measurement areas added based on the findings of Van der Meijden [51] and evidence from the literature [53]. One of the significant features is the framework's emphasis on the relationships among the measures, which is derived from the influence of the D & M model. It embraces the concept of relationships by retaining the relational significance of the components.

The resultant framework that has been adopted by Canada Health Infoway encompasses 20 evaluation measures. The aspects covered by the measures of this evaluation framework as represented in the Infoway Benefits Evaluation Framework [53] can be described as:

- System quality – This set of measures is related to technical components of the system. They assess the functionality and security features as well as the system's performance. The details to answer questions relating to this set of measures can be derived from system design diagrams, and system logs. Observational studies will also be useful for gathering data to assess this measure.
- Information quality – Data flow and use qualities are assessed by these measures. Data quality measures among which are: accuracy, completeness, consistency, timeliness, believability and interpretability are the focus of the content and

availability measures. This is the measure that involves examination of individual data elements to ascertain that the contents are representative of the results of the system's processes.

- Service quality – This measure provides insights to the system's ability to respond to changes. Does it have the capacity to meet changing demands? Is there adequate support to enable users to feel confident in exploring the functionalities of the system?
- Use - This addresses the patterns of use, both actual and as perceived by users. A component of the use aspect is to encourage usage by determining the factors that are necessary to increase the number of system users. It also investigates the features of perceived and actual usage by discovering factors such as frequency, duration, location, and type of use. While fulfilling the assessment requirements for this measure would include a user-targeted approach such as a usability survey, system audits can provide useful answers as well.
- User satisfaction – As a measure, it bears a multi-dimensional view. Addressing the user's abilities, user's feelings and the system's features to support use. User-friendliness is one of the important values being assessed. User-friendliness is a quality that can influence the other factors of competency and user satisfaction.
- Net benefits – This measure focuses on the outcomes of the system's use. It captures the positive effects of system use. It is a measure that is related to providing details of population health and the changes in health status that have been effected by the system. Areas of interest include disease surveillance, clinical outcomes, quality of care and financial returns.

An extension of the Benefits Evaluation Framework was proposed to address the socio-organizational and contextual factors not covered in the initial model [54]. The extension includes the addition of two levels for assessment. These are an intermediate layer with dimensions for people, organization, network and implementation, and an external level which will consider the role of technology standards, professional practice, funding and incentives, and legislation and policy [54]. While the extended framework addressed the deficiencies of the earlier version, its validity had not yet been established.

A Benefits Evaluation Indicators Technical report was also prepared to provide system specific guidance for evaluations of laboratory, drugs, diagnostic imaging, public health, telehealth and interoperable EHR systems. There have been numerous evaluation studies conducted that are relevant to the dimensions of the Benefits Evaluation Framework [40]. In an analysis of 50 systematic reviews of HIS evaluations, there were additional measures identified that were not components of the Benefits Evaluation framework [40]. There were 39 additional metrics in 7 categories: patient and provider, incentives, implementation, legislation and policy, correlation, change and improvement, and interoperability. This illustrates the potential for extension of the Benefits Evaluation framework to cover these areas. However, the desire to keep such approaches simple to aid in application has to be balanced with the need for coverage of indicators. The challenge for this framework is to extend the areas of focus without losing its ease of use.

3.2.3 HEALTH METRICS NETWORK EVALUATION FRAMEWORK

As a product of the Health Metrics Network (HMN), which is aimed at strengthening the health systems of less economically developed countries, the National HIS

Assessment tool is designed to evaluate the functioning of national HISs. In evaluating the competencies of nationwide HISs the assessment tool is designed to examine the information and statistical accuracy, as well as, determine how the captured data is utilized to support the productivity of the health sector [13].

The assessment tool has been structured on the principles of the HMN Framework: HIS resources, indicators, data sources, data management, information products and dissemination and use. It comprises 197 predesigned questions with the capacity for additions for local variation. It represents a quantitative measurement scheme; responses to the questions are scored using a Likert scale ranging from 0-3. The rating scale is identified as:

- 0- not adequate at all
- 1- present but not adequate
- 2- adequate
- 3- highly adequate.

The final tabulation provides a quintile rating for the country's HIS [55]. Using a methodology that allows collective responses to the assessment is suggested as the ideal approach for utilizing this assessment tool [13]. Assessments such as this in the view of the WHO are to be a part of a larger consultative, collaborative, development process for countries [13]. The results of the assessment are intended to provide evidence for areas of improvement. It aims to support the development of national HISs that have met the standards of functionality as outlined by the WHO HMN's framework. As an ongoing activity, a national assessment is designed to inform on a country's progress in meeting those goals.

One of the significant emphases of this evaluation framework is the role of the stakeholders. It is noted that these assessments should involve a wide range of stakeholders, representing all levels of interest [13]. The assessment is designed to provide stakeholders with the ability to follow the progress of the country by providing checkpoint data in the areas of health statistics, data sources and information products [55]. It is recommended that the composition could include personnel from the national statistics entity, government representatives from the ministry of health, associated ministries and governmental entities, academic institutions, donor agencies, United Nations organizations, non-governmental organizations and civil groups [13].

For its role as a country-wide evaluation tool the HMN Assessment tool is lauded for its approach to acquiring comprehensive feedback; its ability to inform decisions on national strategic investments; the ability for its adaptation to the country and the potential for cycles of assessment and feedback over an extended period [55]. As an assessment tool applied to countries, the challenges lie in the impracticality of comparative analysis of results between countries along with the inability to perform the assessment over shorter timeframes because of the detailed and extensive approach [55].

The HMN Assessment tool includes an evaluation of the national health data sources. This examination of multiple sources can be useful in supporting the validity of data that has not been supplied in a timely manner and providing a comprehensive list of health status indicators [55]. On the contrary the assessment tool cannot guarantee 100% accuracy and relativity can influence the responses provided. This can limit its capacity for use as a standard in between country comparisons. In reporting on the country-wide health status, the tool does not show how the result is connected to the other sectors of the

HIS [55]. While its use is encouraged for assessing health indicators, there is no evidence to support its use as a method for health surveillance [55].

The HMN Assessment Tool gives the ability to analyze the contribution of all of the national health data sources. This is valuable to the WHO because an assessment of the civil registration data source can provide regular information on population coverage in an easily understood format. But this would be counterproductive as regular trending would not yield significant changes [55].

The HMN Assessment tool enables comprehensive review of the components of national HISs. The inclusion of a wide range of stakeholders in the evaluation process is an important accomplishment. However, the extensive list of indicators and the time required to complete the evaluation are limitations to its consistent use.

3.2.4 CHEATS FRAMEWORK

The weaknesses of traditional approaches and the absence of organizational effects in older evaluation models motivated the development of the CHEATS framework for evaluation. CHEATS represents the following areas of evaluation: clinical, human and organizational, educational, administrative, technological and social [56]. It is designed to reflect the multidimensional impact of utilization of technology in healthcare and fill the gaps of the traditional evaluation approaches. Although these traditional approaches can be utilized for the evaluation of other healthcare elements such as medications, the reality is that there is no evaluation approach that fits every setting, and these traditional approaches cannot be applied in the area of health ICT [56].

CHEATS can be described as the all-inclusive framework, based on the general expectations for the utilization of information and communication technology. Its dimensions are wide-ranging and cover the technological and contextual impacts of ICT utilization. Following is the description of the dimensions of the CHEATS framework [56].

The clinical component presents the most factors to be evaluated. The factors focus on determining the effect of utilization of information technology on the patient's health outcome. The impact on quality of care, diagnosing, and continuity of care are measures used to address how the technology supports the physician in providing care. There are several measures that relate to the effect of the technology on the practicing environment, workflows and attitudes. There is emphasis on the attitudes of the provider and the patient. Referrals are also examined in this area; the interest is in whether the technology has caused a change in the referral rates and the results of those referrals.

The human and organizational effect is sought through an analysis of the communication arrangements of personnel at all of the healthcare levels: primary, secondary, tertiary and community. Changes in the interaction and collaboration styles within the organization as well as in the patient- provider interaction are evaluated.

An evaluation of the educational factors would highlight the benefits to the healthcare professionals in terms of the acquisition of knowledge and skills. Healthcare professionals can provide feedback on the usefulness of educational initiatives to their professional development. The content of these educational initiatives and the delivery context would also be evaluated.

In the administrative domain the emphasis is on the effect of computerization in supporting scheduling and data collection; assessing the benefits for patients and providers through improved access. Cost analysis is a useful approach to evaluating the administrative effects [56]. It provides support for funding decisions and validates incurred expenses.

Technical components, which are often blamed for failure [56], can be evaluated by examining:

- whether the appropriate technology was used
- whether differences in system flows are affecting outcomes
- whether the system is easy to use
- what is the quality of training, how reliable is the system and what are the contingencies for the risk of failure and
- in some cases, is the maximum quality provided by video and sound transmission

The system's integration into the healthcare environment is included in this criterion and would enable a judgment by the users about the contribution of the system. It is also recognized in this dimension that the variances in system flow among similar systems can influence usage patterns. It seeks to determine if this occurs.

The final aspect of this evaluation framework examines the effect on social relations. Noting that there may be a reduction in personal contact in a rural setting with the introduction of information technology applications, this dimension of the framework will determine whether the effects are adverse or beneficial.

The limitations of this framework are found in the impossibility of evaluating every aspect of an ICT implementation. However, it can form the basis for identifying the aspects to be evaluated [56]. In applying this framework it is critical to determine which aspects are relevant. The recommended use of both quantitative and qualitative methods in practice is valid given the extended range of areas to be addressed. The CHEATS framework needs further work to refine the scope of the technical, human and organizational factors [10].

The CHEATS evaluation framework addresses the factors that should be included in the evaluation of health ICT. It allows the evaluation of a set of general factors. A review of the factors is needed to specify the areas of inclusion more clearly.

3.2.5 BALANCED SCORECARD

The Balanced Scorecard was produced to enable the transition of organizational or business strategy to specific measurable goals [57]. As a strategic management tool, [28] it provides a selection of critical success factors [57]:

- financial – factors that enable profitability
- customer – factors that are important to customers e.g. time, quality, performance, service, and cost
- internal business – factors with the greatest impact on customer satisfaction
- learning and innovation – factors that will enable change and improvement

Its theory is that the strength of the financial measures is supplemented by other operational measures to provide a comprehensive look at the entity [57]. These other measures act as predictor variables [44] and enable an evaluation of ‘intangible’ system

attributes [58]. The selected measures are determined by the entity and the workforce determines how the performance measures will be met [57]. Important to this model is the balance between priorities and the causal relationships established among the success factors [44].

While this framework was designed for business applications, the Balanced Scorecard can be customized to the organization, so its use has been extended to other areas including healthcare [58, 59]. This adaptation of the Balanced Scorecard details a patient perspective, financial perspective, learning and growth perspective and an internal business perspective. It is interested in the patient's view of the quality of care provided, financial goals, maintaining innovation and the businesses strategies to achieve patient satisfaction and financial success [58].

One of the strengths of the Balanced Scorecard is the focus on a limited set of crucial indicators. The Balanced Scorecard was proposed as the model for evaluation of a national health information strategy [44]. The strategic focus made its use adaptable for this purpose. There is value in the Balanced Scorecard's capability as a strategic management system and not as a measurement system [59]. So while it may be suitable for measuring strategic success, it may not be useful to address other areas for HISs implementations.

The strength of the Balanced Scorecard in assessing strategic value is evident. It would be useful in areas relating to healthcare strategy but its application in other areas is not proven.

3.2.6 VITAL WAVE'S HIS MATURITY MODEL

The Vital Wave HIS maturity model uses five focus areas to determine the progress towards national integrated HIS. It applies a stepwise classification principle that is based on data flow and collection, data utilization and integration, resources and capacity, scope and scale. The maturity of a HIS is informed by its ability to fulfill the recommendations. The maturity of a HIS is ranked in stages, from one to five [8].

Stage one identifies HISs that utilize manual data collection with non-streamlined data collection processes. The HISs at this stage also feature poor reporting and data quality with silo systems and little or no capacity for information use. The emphasis is on district level data collection processes utilizing several systems in the country. These are often manual data collection systems. In some countries, however, the development of HISs began with the electronic collection of all data sets [16]. Because of the emphasis of this model on creating efficient data processes, it can be assumed that these countries will also be assessed at the preliminary stage. It underscores the fact that the presence of technology does not negate the presence of inefficiencies and anomalies.

The second stage requires organization of data collection with the establishment of a core set of indicators. This drives the data collection process for faster and more relevant data capture. While there is still no integration among the disparate systems, the capacity for monitoring and evaluation at a central level is visible.

As the development progresses, access and use of electronic data storage and reporting facilities is routine. While aggregated data cannot be traced to individual records, there is comparison of data from the other existing systems. At this stage also, the scale of the system begins to increase to cover an entire district or more.

In the final stages there is an emphasis on the capabilities of electronic data capture, individual electronic records, and integration of multiple health related systems. This system would provide coverage of the entire population with information used for guidance in care, management and decisions.

The Vital Wave Maturity model enables a view of the overall HIS. It outlines the activities for development and the obstacles that need to be addressed [8]. This framework's minute emphasis on functionalities may be the key to its usefulness. It presents a maturity scheme that amply addresses the multiple determinants of overall system performance. It highlights the technical, social, organizational and cultural aspects of a national HIS and fits excellently with the context of developing countries.

The Vital Wave staging approach builds on the usual conditions existing in HISs development in developing countries. This stepwise assessment provides benchmarks for achievement and descriptors for system attributes at each stage. It is useful for evaluating progress and envisioning the next steps.

3.2.7 PRISM FRAMEWORK

The Performance of Routine IS Management (PRISM) framework is a contribution to the task of large-scale evaluations that focuses on assessing the internal performance of health management information systems. The framework is based on the premise that technical, organizational and behavioral factors are determinants of performance [14]. Performance is viewed as a characteristic of the health management information system. Performance is influenced by processes. Processes in turn are influenced by the technical,

organizational and behavioral factors, either directly or indirectly. While there is also influence among the factors themselves.

Technical and organizational factors can influence each other or they can influence behavioral factors. It establishes that the performance goals can be affected by these factors or by the processes of the health management information system. In this regard this framework is target-oriented, identifying a goal and linking its achievement to either factor(s) or processes. By this method the factors negatively affecting performance can be identified.

The PRISM framework selects its areas of focus by limiting its range to only routine HIS functions, primarily service delivery and resource management. In practice this framework is applied through a performance diagnostic tool with four components: 1) the Routine Health Information System performance diagnostic tool, 2) the Routine Health Information System overview tool, 3) the Routine Health Information System management assessment tool, and 4) the organizational and behavioral assessment tool.

The PRISM set of evaluation tools are useful for monitoring the performance of the organization. The focus on internal processes and factors is relevant but limited. The system's evaluation should also account for its performance in its operating environment by considering external factors.

3.2.8 OTHER APPROACHES AND FRAMEWORKS

While there are structured frameworks that are applied repeatedly, sometimes the focus of an evaluation is determined by priorities, context and stakeholders groups. In assessing the implementation of computerized hospital ISs in Limpopo Province, South

Africa an evaluation framework developed through consultations with potential users and stakeholder groups was utilized [35]. This assessment was intended to provide guidance for the project phase, as well as, evaluate the outcomes [35]. The evaluation framework was developed to represent 10 areas of interest [35].

- Training, change management and support
- Reliability of system components
- Project management
- Communication of patient information between healthcare facilities
- Data protection
- Quality and use of information to support decision making for clinicians, hospital management, provincial personnel and the public
- Standardization and efficiency of patient administration processes
- Costs per unit service
- Revenue collection
- Use of information for audit or research

A comparison that focused on 10 countries [33] was based on the benefits of technologies as indicated by the literature. It used a quantitative approach to assign numeric percentages to the use of ICT applications, as well as, perform a ranking of perceived benefits by general practitioners.

The Finnish approach towards evaluation of national health infrastructures [60] was created from the best practices of other evaluations. The result was an evaluation plan with activities during the different phases of the project life cycle and dimensions for assessment based on the legislated requirements [60]:

- Quality of development process
- Meeting the set requirements
- Successful implementation
- Improvements in service processes
- Quality improvements
- Positive health impacts
- Cost benefits
- Secondary impacts
- National Social IS boost
- Future service models

Different factors for evaluation are determined by different stakeholders. The following six areas were earmarked for evaluation through the Health Information Technology Evaluation Collaborative to examine the effectiveness of the strategic health sector plans within the city of New York [61].

- Health IT Adoption Measurement
- Provider
- Economic Value
- Quality and Safety
- Consumer
- Public Health

3.3 APPLYING FRAMEWORKS

Frameworks are limited because of the underlying philosophy, theory and assumptions [28]. These provide their basis and ultimately their focus, configuration and scope. Thus, evaluations have been domain-oriented, seeking to answer questions from a technical, sociological, economic, human, and organizational or a combination of any of these points of view [10].

There cannot be one framework to address the myriad of perspectives that are brought into an evaluation [43]. The differences in types of healthcare organizations, the primary stakeholders and their interests will also influence the focus of the evaluation, [43] and hence the framework utilized. Some of the options among existing frameworks are: generic, system development life-cycle based or socio-technical based [10]. This limits their use and forces consideration of the two inquiries that influence the emphasis of an evaluation. These questions are: ‘Why do you want to evaluate?’ and ‘What is it going to be used for?’ [28] The answers to these questions will provide guidance on suitable frameworks. Therefore in applying frameworks the area of interest must be known to enable useful application of the framework’s theory.

In a review of 12 frameworks it is noted that they are complementary, however, there are differences in the prior assumptions of each framework and how the frameworks are applied [10]. Further they do not provide distinct criteria for evaluation [10]. They allow for modification and contextualization which weakens the ability for generalization. The fact that there is no all-inclusive framework that can be applied for the evaluation of all IS can be confusing for those trying to conduct evaluations.

The perspective of the framework determines its usefulness in one context or another. There is no single framework to satisfy every perspective. The objective of the evaluation must be established as this will influence the framework chosen. This underscores the necessity of a contextually relevant approach for every environment. Not all evaluation methodologies utilize existing frameworks; in some instances an evaluation approach is specifically developed, acknowledging the interests of stakeholders.

3.4 SUMMARY TO CHAPTER 3 AND TRANSITION TO CHAPTER 4

This section focused on the review of seven frameworks that can be used in evaluations. The frameworks examined were the D&M IS Success Model, Canada Health Infoway Benefits Evaluation Framework, HMN Evaluation Framework, CHEATS Framework, Balanced Scorecard, Vital Wave's HIS maturity model and PRISM framework. Other approaches for guiding evaluations were also revealed with their emphasis on stakeholder involvement and requirements fulfillment. The assumptions underlying frameworks were also discussed to establish the influences in framework use. In the following section the developing country context is discussed. This includes a look at the factors that influence the evaluation of HISs in these settings.

CHAPTER 4 STUDYING THE CONTEXT OF EVALUATIONS IN DEVELOPING COUNTRIES

4.1 OVERVIEW

This section is an analysis of the functional environment within developing countries. In this section a description of the context focuses on features of the health systems of developing countries relating to governance, funding and technology. These features are deemed influential to the implementation and subsequently the evaluation of HISs in these settings. A brief description of the Caribbean context follows to share the health-related features and the status of HIS implementations in the region. The evaluation of HISs in developing countries is discussed to identify the common interests of evaluators in developing country settings. These interests will provide insights about factors that are relevant to the evaluation of HISs in this context.

4.2 THE DEVELOPING COUNTRY CONTEXT

4.2.1 GOVERNANCE

The governance of health systems in developing countries is influenced by the political administrations. Governments perform the roles of financier, regulator, manager, and provider [62]. The effect of governance is comprehensive; governance affects the functioning of the entire health system and is therefore linked to the performance of the health system and health outcomes [62].

The governance structure of health ministries and authorities was adapted to create decentralized institutions of service. Decentralization was recommended for addressing the needs of patients in developing countries [21]. This hierarchical approach is intended

to promote access and management of health at the local level, with better opportunities for responsiveness within the health system. This gave rise to the establishment of regional health systems and regional information offices. The primary reason for these changes was the need for better information to support decision-making. To support this objective, health systems were designed as a hierarchical organization to enable capture of data at the lower levels to meet the needs of information users at the upper levels. The local institutions use this information for feedback and improvement purposes, while the central agencies use it to deduce population health trends and perform sector management functions [23]. There is an expectation that HISs which are designed to meet the information requirements at all levels of care, can help fulfill the promise for improving the quality of health management [9]. This is a central theory and continues to be a principle in health sector planning efforts.

The result of decentralization is that there are several levels to be considered when examining governance: the local (e.g. district health authority), national (e.g. Ministry of Health), regional (e.g. Pan American Health Organization), international (e.g. World Health Organization) and global levels [62].

The enactment of these administrative policies while intentionally commendable, in some instances, does not consider the effect of social realities in their application. Two cases that were found present the challenges in applying these policies from differing perspectives.

- In rural communities, the strategy of collecting information from the lowest level health institutions can result in a loss of data from sources within communities [63]. Some portions of the population will not visit health institutions and

therefore, these instances of data are lost. The data was traditionally collected through community-based health assistants. The recommendation is for the administrative model to be adaptive and allow for flexibility in the contributing sources. This recommendation would be applicable for not only rural communities but will also impact other communities where an informal data collection system exists.

- In examining the decision space of decentralization it was revealed that the shift in control to local authorities resulted in the health objectives of the central agency not being pursued [23]. In the absence of mechanisms such as enforcement and monitoring the local institutions or regional agencies are vulnerable to deviations in practice. The lessons here point to the need for consideration of political and social factors when adopting a healthcare model.

These examples also demonstrate the reality that the policies within the environment are influential for directing the progress of information and technology development. The socio-economic policies are very important in this regard [64]. Decentralization while providing autonomy and local emphasis also affects the data collection processes when it is not implemented in collaboration with existing social systems. The financial costs of decentralized vs. centralized data capture models is also important to consider. As results show that decentralized data capture for clinical studies is more costly [65].

While governments assume responsibility for health governance, stakeholders locally and internationally are also participants in the governance processes [62]. The participation of these stakeholders, particularly the international agencies can influence

local strategies through global health initiatives. The effect of this has been seen in the funding priorities of international organizations.

The governance of health systems in developing countries reflects governmental influence and decentralized health systems. These qualities, however, are not specific to developing countries. Perhaps the distinct feature of these health systems, in terms of governance, may be the role of the international stakeholders.

4.2.2 FUNDING

The contribution of a government towards health sector spending is evidence of its commitment to enable better health outcomes for its populace [66]. While health sector funding is known to be primarily sourced from national budgets, the developing country model of healthcare is one that integrates the efforts of donor and other contributing agencies locally and abroad [21]. Historical data has shown that the percentage of funding provided to the health sector by governments in developing countries has increased on an average of 100% between 1995 and 2006 [66]. However, it was also found that government spending was reduced when external, donor funding was provided [66]. It is unclear whether these reductions are directed to other development areas or are used in other ways. When these funds are provided to non-governmental organizations there is not an ensuing reduction in government spending. This may be the reason that non-governmental organizations are used as a means to channel aid financing.

These methods of financing however can be counter-productive and result in multiple organizations pursuing independent objectives. Donor funding programs which are disease specific create an environment with more than one implemented system. Thereby,

limiting the support to a particular segment, and not providing comprehensive benefits across the entire sector [22]. The lack of coordination in addressing healthcare as an enterprise is evident in the multiplicity of HISs that operate side-by-side. These vertical programs can be the result of research or development initiatives and experience not sharing or collaboration. They tend to be disease-specific, service-specific or a management functionality program [9]. The fact that some of these vertical programs address the same issue highlights the deficiencies of this arrangement. The effects have been acknowledged and efforts are being made to avoid the loss in resources that are facilitated by these arrangements. Some funding agencies have introduced steps to reduce this occurrence by initiating changes in proposed funding requirements [21].

Nonetheless the residual structure of this arrangement remains in most countries and presents unique challenges for integrating these separate operations, at least in terms of their information needs. Some countries are addressing this issue by streamlining the funding process to regulate the development activities. Guyana, for example, has noted in its health sector strategy the use of a consolidated account for funding within its health sector. This should reduce the ability of vertical programs to implement parallel systems and instead focus resources on development of the national infrastructure. This is recognized as a strategy that will improve effectiveness and economic value [13].

Funding for health systems in developing countries is enabled by local and donor sources. Previous funding schemes were program focused which resulted in multiple parallel systems. The current interest is to provide funding for initiatives that will contribute to the development of national HISs.

4.2.3 TECHNOLOGY

4.2.3.1 ACCESS

Information technology is posited as a means for achieving development in less economically developed countries. The theme of these sentiments is controversial and the validity of these claims with regard to whose interests they serve is questioned [64]. The theories evident as underlying the study of information technology in developing countries are: 1) the adoption of practices that are operational in developed countries, 2) extending the local culture to facilitate the adoption of technology and 3) enabling technology as a catalyst for socio-economic change [64]. These are valid perspectives to examine the role of information technology in developing countries: adopting practices to meet global standards, changing the operational culture and improving the lives of citizens. These are all challenging and require intense efforts to achieve. One of the negative consequences that can arise relates to the utilization of global standards, a perspective that can result in the imposition of guidelines that are not locally relevant.

The ratings from the ICT Development Index (IDI), a composite index made up of 11 indicators covering ICT access, use and skills, shows the difference in ratings among developed and developing countries (see Figure: 7). While there is inequality among countries the aggressive growth in ICT for developing countries reveals that progress is being made at increasingly rapid rates. This measure, however, is limited in assessing access in developing countries and does not represent the existing reality. The adoption of technology in developing countries is not on a continuum; rather it represents a patchwork of adoption.

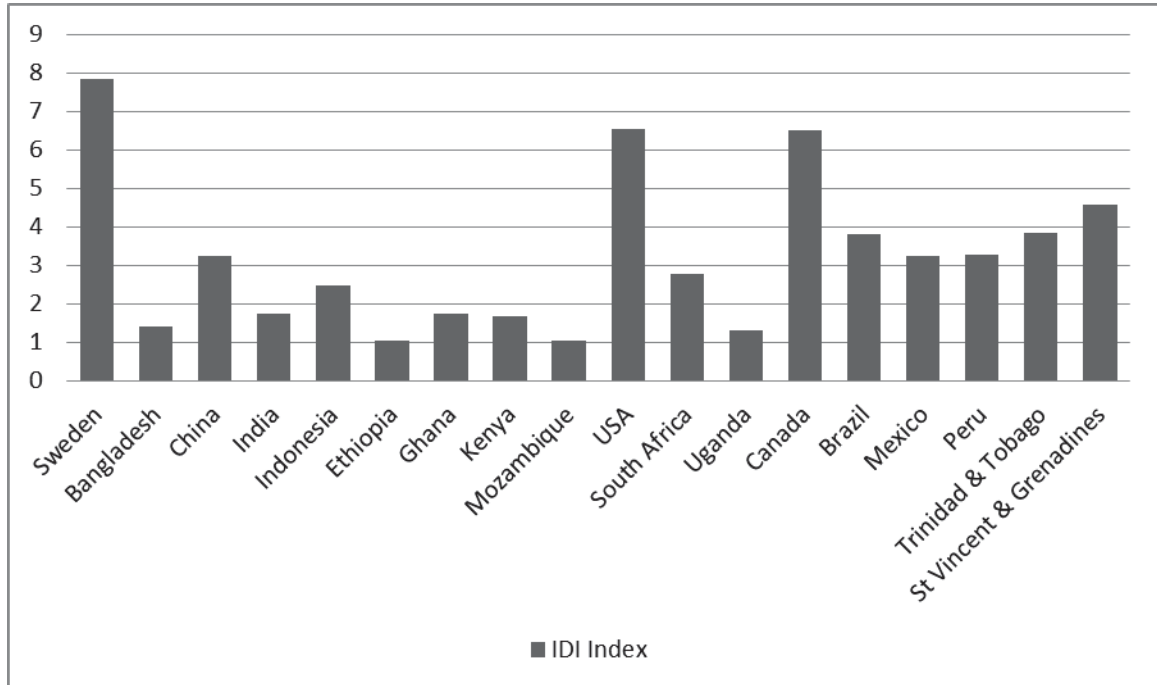


Figure 7 ICT Development Index, 2008
Based on data from [84]

This results in the use of sophisticated technology alongside obsolete technologies [67], implying that access and exposure to relevant technologies is not uniform within countries. In reflecting on the experiences of Latin American countries the following factors were described as contributing to the adoption of technology in this region: income, education, telephone infrastructure, ICT development and ICT experience [67]. These were evident in the wealth inequities, lack of access to technology in schools, limited investments in infrastructure, irregular updates and wider learning gaps for users. This validates the reality that infrastructural support is not limited to the technical aspects of the system but also extends to the existence of dependable physical and communication infrastructure [22]. These factors can also be used to describe the situation in the neighbouring Caribbean region. It is evident that there is a need to

facilitate adoption through the support factors of governmental incentives, standards and an environment that provides technical competency [68].

While developing countries have experienced fast-paced growth in access to technologies, the current pattern of access can be described as a patchwork. The limitations in access can be linked to other deficiencies in infrastructure and education. Initiatives to facilitate adoption can be used to improve the access to technologies in developing countries.

4.2.3.2 E-HEALTH

Currently, rapid changes in the healthcare delivery model are being driven by the internet and wireless connectivity. This has prompted the use of creative solutions to address the needs of the healthcare sector. Stakeholders including governments and donors have also adopted these initiatives. Most of which are deployed as e-health applications. This is against the background of an inconclusive definition for e-health, with at least 36 identified definitions [69]. The scope of its use contributes to this inability to clearly define it. It is noted that the meaning of the term is influenced by the functions, stakeholders, contexts and theoretical issues addressed by the applications [69]. However, this does not negate the impact of this area as signaled by the WHO's e-Health Resolution.

It is accepted that e-health involves the utilization of technological advances in information and communication to support healthcare processes [70-72]. Its potential to effect improvements in the delivery of healthcare is often described optimistically. E-health is described as having the "ability to transcend sociopolitical boundaries" and

“create a borderless world” [71]. However, the current environment does not provide evidence of progress in achieving this global vision.

The development of e-health policies has been a recommended action for countries and is assessed as a measure of progress by the Global E-health Observatory. This recommendation while lauded has drawn critical views, advocating for the development of e-health policies in the context of “glocal” impact [71]. This is necessary when the effect of local actions on the global environment is considered. This is not evident in current policymaking activities in the developing world where the goal is on the development of national strategies [71]. The major concerns for developing countries in creating e-health policy are boosting human resources capacity, improving access and building regional computerized HISs [71]. This is in contrast to the interest of developed countries in this area which is on data issues of security, privacy and quality [71].

Providing evidence of the impact of e-health is recommended to increase its application. However, an evaluation of how patient care is influenced by e-health is challenging to accomplish [70]. In assessing its impact on the provision of healthcare services, interest should be directed to accessibility, affordability and quality [72]. While it is challenging to perform sound evaluations in resource-scarce environments, there is evidence that it can be accomplished [70].

It is assumed that e-health applications will contribute to the improvement of health services through the following [70]:

- Tracking and supporting compliance
- Faster communication times
- Patient identification and registration

- Alerts and reminders
- Data collection with handheld devices
- Lab and medication support systems

The assumption is that there are numerous e-health programs operational in developing countries. This evidence has not been aggregated, therefore, it is impossible to report on the instances and their benefits. It would be useful for data collection agencies, such as the Global Observatory for E-Health, to address this lack of reporting on active local e-health programs.

While there are obvious benefits from its use in developing countries e-health applications cannot serve as replacements for functional countrywide HISs. The challenges associated with the deployment of these e-health projects include: limitations in their target population and geographical range. This results in gaps in the healthcare delivery system and at times duplication of health information. E-health projects are conducted by various stakeholders, each with their own goals, evaluation criteria and benchmarks for success. These limitations support the need for nation-wide HISs to form the basis for e-health applications. This need is very much a reality for less economically developed countries such as those within CARICOM.

The increasing popularity and use of mobile devices in developing countries has led to the belief that m-health has revolutionary potential. This belief is fostered partly because of the impact of mobile devices in the areas of agriculture and banking in low resource settings. Results from the World Health Organisation's second global survey on e-health indicate that 83% of 114 member countries have had m-health programs conducted in their countries. Those included from the region of the Americas are: Belize,

Brazil, Dominican Republic, Mexico, Paraguay and Peru. Of these 6 countries, Peru was the only one to confirm that there had been a formal evaluation or publication about the m-health program [73].

E-health applications are varied as they are adapted to meet the requirements of numerous situations. This has contributed to the difficulty in attributing a precise definition to this set of applications. The expectation for e-health and its contribution to health systems is high, but e-health evaluations are not readily performed. M-health applications are viewed as a potential means of revolutionising healthcare. Evidence of its impact is limited because evaluations of m-health programs have not been routinely performed.

4.2.3.3 HEALTH INFORMATION SYSTEMS

The health sector reforms during the late 80s and early 90s saw efforts to restructure the HISs in some developing countries including Bolivia, Nigeria and Thailand [9]. These health sector reform initiatives recommended the adoption of HISs to support the achievement of better governance. The ability of HISs to provide reliable data for planning and decision-making purposes were seen as benefits that were required for progress within the healthcare sector.

An analysis of the characteristics of an IS can be achieved through the seven dimensions of the ITPOSMO framework – Information, Technology, Processes, Objectives and values, Staffing and skills, Management and structures, Other resources (time and money) [49]. A characterization of developing countries in these dimensions is related as [49]:

- Information – less emphasis on documentation and information repositories
- Technology – limited or old networks for technology and power supply
- Processes – adaptive to current circumstances, constantly changing
- Objectives and values – family loyalty, trust in authority figures, unwillingness to take risks
- Staffing and skills – limited human resources with ICT skill set
- Management and structures – central oversight agencies and hierarchical organisation
- Other resources – less financial resources

These characterizations are also identified as stereotypes [49], but are supported by other references to HISs in developing country settings. Many of these challenges were identified and confirmed in a review of HISs in 16 developing countries. There are 11 factors, listed in Table 2, that were primarily noted as strengths and weaknesses of those existing systems [8].

Strengths	Weaknesses
1. Policy, strategic support and structure	1. Human resources capacity
2. Health sector integration	2. Limited funds and resources
3. Streamlined data collection process	3. Lack of infrastructural support
4. Supportive infrastructure	4. Insufficient health system coverage in rural areas
5. Effective disease specific treatment systems	5. Multiple systems that are not connected, poor data flows
	6. Data collection and quality problems

Table 2 Common strengths and weaknesses of HIS in developing countries [8]

These results show that there is a blend of strengths and weaknesses across developing countries; items that were noted as weaknesses for some countries were identified as strengths for others. This indicates that while these weaknesses can exist, some countries have successfully addressed them. There is no predefined set of characteristics that will describe the HIS environment in any developing country.

The challenges of operating in this environment, however, are not indicators of failure; as innovative methods have been used to address and overcome these challenges. Some of these innovative methods are described in Table 3. The research efforts indicate that the issues relating to use are of more interest to researchers and the limitations are not hindrances to implementation [64].

Challenges	Mitigating actions
<ul style="list-style-type: none"> ▪ Achieving local buy-in 	Working with a local project champion; liaison between clinical staff and developers
<ul style="list-style-type: none"> ▪ Maintaining accurate service records 	Paper registry or local database
<ul style="list-style-type: none"> ▪ Improving data collection 	Enabling local data access and use
<ul style="list-style-type: none"> ▪ Developing systems that can scale up with time 	Utilize existing systems with the ability to scale, that have been proven to work
<ul style="list-style-type: none"> ▪ Meeting the design goals of the system 	Focus on the outcomes and how the system can support those goals
<ul style="list-style-type: none"> ▪ Data collection to support evaluation and comparisons 	Use a core data set for all entities
<ul style="list-style-type: none"> ▪ Improving data quality 	Staff training; field validation for data entry and system reports on data quality and completeness

Challenges	Mitigating actions
<ul style="list-style-type: none"> ▪ Lack of electricity or computing resources 	Local data capture using paper forms and data entry performed offsite at central database
<ul style="list-style-type: none"> ▪ Limited support team 	Use web-enabled software and remote access, limiting local support requirements to internet and basic support
<ul style="list-style-type: none"> ▪ Unreliable internet 	Local storage with periodic uploads, ideally automatic synchronization; mobile phones and PDAs
<ul style="list-style-type: none"> ▪ Multiple needs 	Prioritize to increase gains by implementing the solutions that provide the most benefits
<ul style="list-style-type: none"> ▪ Unreliable power supply 	Uninterrupted power supply equipment and battery-backup devices
<ul style="list-style-type: none"> ▪ Data security at remote sites 	Web-enabled software, data synchronization., portable drives, audit logs
<ul style="list-style-type: none"> ▪ Ensuring patient confidentiality 	Password protection and encryption (with user training), audit logs
<ul style="list-style-type: none"> ▪ No infrastructure 	Utilizing mobile devices
<ul style="list-style-type: none"> ▪ Knowledge of what works 	Evaluation studies
<ul style="list-style-type: none"> ▪ Lack of local knowledge for development support 	Training local developers

Table 3 Methods to address challenges in developing countries [74]

The environment of developing countries can provide challenges for IS implementation. These challenges are well known and much discussed. However, there are mitigating actions that support the operations of HISs in this setting. When these actions are utilized it can enable the successful implementation and use of HISs in developing countries with challenging conditions.

4.2.4 THE CARIBBEAN HEALTHCARE SYSTEMS

The individual country rankings of the Caribbean and Latin American region provided by the World Bank reveal that most of the economies are within the upper middle income classification; eight are lower middle income countries while Haiti is classified as a part of the low income group, (see Appendix: A). In the minority are high income countries, Barbados and Trinidad and Tobago. The general view is one of developing economies.

The health related statistics reported in Table 4, present small population sizes within the regional countries. There is an average of 255,465 individuals per country when Haiti, Jamaica and Trinidad are excluded. Most of these countries are post-colonial settings with political structures that were influenced by those of colonial countries. The current average life expectancy of 72 years indicates that these countries are making progress in addressing major threats to life expectancy. It also indicates that these countries will require health systems that can adequately address the needs of elderly patients. Significant numbers among their populations live in urban areas; this is influential in examining access to health-related services and also influences the surveillance programs that are employed. The health sectors are not depicted as elaborate, with lower amounts spent on healthcare when compared to developed countries.

The implementation of HISs in the Caribbean is representative of patchwork systems. It is noted that the present situation is characterized by excessive data collection through disconnected systems [75]. The scenario of healthcare professionals with an inability to

readily access “timely, complete, accurate, reliable, and relevant information” to support decision-making for strategy or patient care [2] is applicable to the CARICOM region as well. The need for functioning HISs was highlighted through the inability of current systems to provide data for a regional study [76]. The inadequacy of the health system in 7 countries: Antigua and Barbuda, Bahamas, Barbados, Guyana, Jamaica, St. Lucia and Trinidad and Tobago, was revealed. Cunningham-Myrie noted the difficulty to collect data relating to two of the non-communicable conditions that are prevalent in the region, diabetes and hypertension [76]. This lack of reliable data is common for other conditions as well. The value of information to support patient care or decision-making has been the underlying reason for the recommendations for national iHISs. However, the migration to national iHISs has been slow. One obvious challenge for some countries is to accomplish this in the presence of multiple, disconnected systems.

The evaluation of HISs in the region is not a regular activity. There is a lack of literature to support conclusions beyond this. Nonetheless, the potential for improving this component of HISs is seen in the role of the regional CARICOM Secretariat. The evaluation of HISs in the region will enable stakeholders, policymakers and citizens to examine the performance of current systems. Evaluations will provide information to support actions for improvement.

Country Name	Population, total	Adults [ages 15+] living with HIV	Life expectancy at birth, total [years]	Urban population [% of total]	Fertility rate, total [births per woman]	Health expenditure per capita [current US\$]	Health expenditure, public [% of government expenditure]	Hospital beds [per 1,000 people]
Antigua and Barbuda	87,802	..	..	30	..	653	11	2
Bahamas, The	338,358	6,100	75	84	2	1,558	13	..
Barbados	272,750	2,300	76	40	2	1,041	11	..
Belize	333,200	4,400	76	52	3	217	12	1
Dominica	67,922	..	..	74	..	361	12	4
Grenada	104,097	..	75	31	2	447	9	2
Guyana	753,013	5,500	69	28	2	133	15	..
Haiti	9,864,241	112,000	61	48	3	40	9	..
Jamaica	2,695,600	30,000	73	54	2	231	6	2
St. Kitts and Nevis	51,752	..	..	32	..	634	8	6
St. Lucia	172,092	..	74	28	2	443	12	1
St. Vincent and the Grenadines	109,269	..	72	47	2	301	9	..
Suriname	519,861	3,600	70	75	2	429	15	..
Trinidad and Tobago	1,336,349	14,300	70	14	2	1,069	10	..

Table 4

Health related statistics for the members of CARICOM

Source: World Bank data, Health nutrition and population statistics [77]

4.3 EVALUATIONS OF HEALTH INFORMATION SYSTEMS IN DEVELOPING COUNTRIES

4.3.1 AREAS OF INTEREST

The evidence about IS in developing countries is characterized by a lack of literature, an absence of evaluations and an overwhelming application of the case study methodology [47]. But in spite of the missing evidence, the existing literature affirms that there are high rates of failure among IS in developing countries [47]. There have been innumerable studies conducted on the effectiveness of small scale HISs; these may be at an institution - as in the case of hospital IS, or specialized systems such as clinical decision support systems. However, there is not an abundance of articles that offer details of evaluations performed for national HISs. The reasons for this can be explained as:

- Small number of fully deployed national HISs
- Reluctance to publish
- Inadequate funding for performing evaluation activities.

An effort was made to examine the emphasis of evaluations for large-scale HISs in developing countries. Finding publications on these types of evaluations is difficult, as they are often not described in terms relating to evaluations. A list of those evaluation type publications that were encountered is presented in Table 5.

The evidence of independent assessments for large-scale HISs is lacking, particularly for developing countries. A strong emphasis on improving the quality of the national data is reflected in the existing reports.

Author, date and country	Type of HIS	Research Interest	Study design	Findings
Kanjo, C. 2011, Malawi	Health management information system	Data quality	Case study	Health practice policy implementation should be accompanied by situational analysis to ensure data quality
Kimaro, H. and Nhampossa, J. 2005, Mozambique and Tanzania	Health information systems	Sustainability	Case study	Local capacity, adaptable systems, and redefinition of stakeholder roles are needed for sustainable systems
Ashwell, H. and Barclay, L. 2009, Papua New Guinea	National health information system	Data validity and reliability	Mixed methods	Data should be identified from the lowest levels to enable feedback to the community level
Adindu, A. and Babatunde, S. 2006, Nigeria	Health management information system	Information quality	Survey	Applying a utilization model that emphasizes information use at the local levels will improve the data quality
Littlejohns P., Wyatt J., and Garvican L. 2003, South Africa	Integrated hospital information system	Formative and summative factors	Mixed methods	Failure in implementation results from social and cultural factors, healthcare complexity, divergent stakeholder goals, organisational changes, personal interests and lack of insights from other implementations

Table 5 Independent assessments of HISs in developing countries

4.3.2 LESSONS AND INSIGHTS

The implementations of HIS in developing countries have resulted in a large number of sustainability failures. This is also common for IS in other areas. It is not a recent phenomenon and has been blamed on the way projects were conducted. The donor provided personnel were often foreign-sourced with inattention to the development of the local skills in technological areas [64]. The support of the local human resource capacity is necessary to enable the system's adaptability to changing needs over time [22]. The absence of sufficient skilled professionals to support the implementation and management of HISs limits this adaptability and results in systems becoming functionally obsolete. Sustainability as a quality is not static and evolves with changes [78]. This makes the ability to accommodate change even more necessary.

The local socio-economic conditions are significant contributors to the deficiency in the sustainability of HISs in developing countries. The technical quality of the system while useful can be dwarfed by the environmental factors, unless there are strategies to mitigate them. The quality of the infrastructure, personnel, lack of political and strategic guidelines and donor funding practices that do not consider continuity, influence the sustainability of HISs in these countries [22]. The factors contributing to systems that are not sustainable also include HIS implementation that is unaccompanied by health sector reform and the rationale that the system's implementation is a pilot [78].

The introduction of IS into settings where they did not exist before is accompanied by a cultural change. The cultural shift that is required does not occur automatically but has to be managed so that the change is integrated into the local culture. When the cultural shift is successful, the system is viewed as a component of the society. This shift provides

momentum for the system's adoption as a locally owned and controlled entity. When the efforts to transfer ownership and control to local partners fail, the demise of a system may follow [22]. To successfully accomplish the cultural shift and local adoption, it is important that local stakeholders be involved in managing the system [22]. The system must be viewed as theirs; this fosters empowerment among the local partners. Sustainability can be found when the local societies are engaged in utilizing the system to meet their own needs [78].

The strategies for improving sustainability include addressing technical, as well as, organizational factors [22]. The first requires integration of several parallel systems within the country [22]. It is noted that this is not limited to technical integration, but emphasizes a collaborative environment that supports the goals of all stakeholders. Along with building the local expertise to support the system through development of human resource capacity, the second requirement focuses on consideration of the local context [22]. Addressing the cultural changes and adaptations, by viewing all levels within the organization is essential. Finally, there should be nurturing of the existing networks of people and technology to create a cohesive entity [22].

The system's sustainability is closely aligned to the local involvement and ownership of the system. Developing the local expertise is critical to a system's life cycle because it enables changes to be facilitated over time. A system that has been institutionalized in the setting, becoming a part of the normal activities is more likely to be sustainable.

4.4 SUMMARY TO CHAPTER 4 AND TRANSITION TO CHAPTER 5

The features of the developing country context have been explored in relation to governance, funding and technology. The influence of governments, stakeholders and the infrastructure in these areas were discussed. The evidence for large-scale system evaluations is limited. Nonetheless, there are areas of interest: data quality and sustainability. These were gleaned from publications of previous experiences; and are deemed important to the quality and success of HISs in developing countries.

CHAPTER 5 STRENGTHENING THE CAPACITY FOR EVALUATIVE ACTIVITIES IN THE CARIBBEAN

5.1 OVERVIEW

The activities to enable the development and use of national iHISs in the Caribbean are growing. In the absence of a generic gold standard for evaluating the iHIS, the goal is to provide an evaluation approach to improve the regional capacity for independent evaluations of these systems.

Evaluations provide evidence for guidance about future developments in HISs [Chapter 2]. Evaluations provide an indication of whether the expected results are achieved and can be used to identify the reasons behind successfully developed HISs [Chapter 2]. The use of evaluations to impact policy and management decisions has become routine, informing the allocation of development funding [79]. With confirmation of successful implementations there will be evidence to support the development of iHISs in the Caribbean region.

In the following discussion an evaluation approach along with an evaluation tool will be presented for use in evaluating the progress for national iHISs. This discourse is accompanied by the analysis of several influential factors to be considered in this context.

5.1.1 THEORETICAL BACKGROUND

The 3 theories of evaluation research [Chapter 2] are all relevant in this approach to evaluations of iHISs in the Caribbean. It utilizes principles of the theory of use through a focus on the utilization of the evaluation results. The principles of use contribute to the identification of evaluation participants. The theory of value is applied to coincide with

the theory of use. The theory of value is applied in this approach to define the role of the participants as the authorities for assessing value. This underpins the essential focus of a participatory evaluation. The approach outlined here relies on the use of proven research methods. The theory of methods will contribute to the creation of knowledge about the implementation of national iHIS in the Caribbean region.

5.1.2 ASSUMPTIONS

The major supposition in presenting this approach is that the national iHIS is the goal for regional health systems. Within the region the highlighted model is the BHIS [Chapter 1]. Given that the implementation guide is the BHIS, the basis is that evaluations will include (in addition to other areas) resource utilization, public health performance and individual health outcomes; as these are the underlying principles of the BHIS model [Chapter 1]. It is expected that this approach will provide evidence to support the development processes for other national iHISs.

5.1.3 PURPOSE

The goal of an evaluation is to provide answers that can be used to inform decisions [Chapter 2]; in this case it is to provide a reference for iHISs development in the Caribbean region. The two inquiries that influence the emphasis of an evaluation are: ‘Why do you want to evaluate?’ and ‘What is it going to be used for?’ [28] In this instance these inquiries can be addressed as follows:

Why do you want to evaluate?

- To promote the development of the healthcare sector in regional countries

- To improve the quality of health services provided to the populations within the region
- To document evidence for similar countries within the region

What is it going to be used for?

- To provide evidence to support the implementation of iHISs in the Caribbean region
- To report the progress of national iHISs and the prevailing conditions
- To identify areas for systems strengthening
- To identify failures and successes along with the contributory factors
- To provide guidance for policymakers and donors
- To support improvement in the quality of systems developed
- To identify areas for improvement in health information services delivery

These objectives are the basis for this evaluation approach, supporting the goals of healthcare and also supporting the development of iHISs within the Caribbean region. The value of an assessment activity cannot be confirmed at the outset, this is in spite of a clear description of the methods. But the possibility of success in enabling improvement is a worthwhile motivation for performing these activities [80]. These stated goals are useful motivators to direct the focus for evaluation activities within the region. The outlined goals can be achieved by the application of the CHEATS+ evaluation tool.

5.2 CHEATS+ EVALUATION TOOL

5.2.1 DESCRIPTION OF THE CHEATS+ EVALUATION TOOL

The evaluation of HISs should focus on technical, social and organizational factors [Chapter 2]. The quality of health outcomes is also of importance. An approach for evaluation should provide a tool for evaluating all related factors. Frameworks are expected to fill these roles of establishing areas of focus for researchers and developers [32], but have not been successful in meeting all of the objectives. Because frameworks are limited in their philosophies, focus and application, the objective was to create an assessment tool for the iHIS based on the most comprehensive framework and the 110 success and 27 failure factors for HISs [81].

The evaluation tool utilizes the principles of the CHEATS framework [56] as an inclusive perspective for HISs; the success and failure factors [81] as a list of qualities; and the lifecycle evaluation plan [28, 32] as a scheduling method. These components address the assortment of factors to be considered in evaluating HISs. This combination is supplemented and refined with other contextual factors to provide an evaluation tool to address significant factors over the life of a system, from planning to operationalization. The long-term nature of this evaluation tool conforms to the requirements for the continuous performance of evaluations. It also fulfills the necessity for a formative and a summative focus for evaluations.

5.2.2 METHODOLOGY FOR THE DEVELOPMENT OF CHEATS+ EVALUATION TOOL

Considering that evaluations should be applied throughout the life of a system, the premise of this evaluative approach is that the success or failure factors can be matched

to the system lifecycle stages. The lifecycle evaluation approach has been proposed by previous literature [28, 32]. While the life cycle evaluation plan is not novel, there has not been an approach to specify the factors to be evaluated in the lifecycle phases of health information systems. Previous suggestions have focused on the evaluation of project documentation and deliverables, and have not focused on the evaluation of contextual factors.

The factors used for selection of the preferred framework included factors that address: the tenets of the BHIS (health and resources emphasis), the participation of stakeholders, technical and non-technical emphasis, formative and summative capability, research flexibility and integration and sustainability focus. The following list, provided in Table 6, was used for the selection based on the factors mentioned above.

Scope	Frameworks						
	D&M IS Success	Balanced Scorecard	HMN	PRISM	Canada BE	CHEATS	Vital Wave
Health outcomes			X		X	X	
Resources (financial outcomes)		X			X	X	
Technical factors	X				X	X	X
Social and organisational factors		X		X	X	X	
Active stakeholder participation			X				
Summative capability	X	X	X	X	X	X	X
Formative capability	X			X			X

Scope	Frameworks							
	D&MIS Success	Balanced Scorecard	HMN	PRISM	Canada BE	CHEATS	Vital Wave	
Methods independent	X	X			X	X		
Context independent	X	X				X		
Integration								
Sustainability								

Table 6 Framework selection

Upon the review of the categories in Table 6, the CHEATS [56] framework was selected as the preferred HIS evaluation perspective. In addition to the categories for HIS evaluations, the contribution of the CHEATS [56] framework to this approach is enhanced by the ability to extend this framework. This was important because of the need to extend the existing evaluative dimensions and also incorporate factors relating to integration and sustainability. The CHEATS [56] framework also provided the flexibility for extensions or modifications that may be deemed necessary for the context. It was also important to utilize a framework that provided the ability to investigate health outcomes; this was very significant to the framework selection process.

The development of the CHEATS+ evaluation tool began with the adaptation of the 110 success and 27 failure factors [81], (see Appendix: B). In adapting these factors the emphasis on national health systems was the major influence. Some factors did not require any adaptations as they were provided in general terms that would be applicable for national iHIS. These adapted factors were then mapped to the areas of evaluation provided by the CHEATS [56] framework. An additional category was added, denoted

by + to identify miscellaneous factors; hence the tool is named CHEATS+ to recognized that it is adapted from the CHEATS [56] framework. The principles adapted in the CHEATS+ evaluation tool are:

- Clinical – addresses the effects of the system on healthcare provision. Factors in this area can be based on individual health and population health influences.
- Human and Organizational – the emphasis is on how the system affects the human and organizational elements such as communication and workflows. The factors relating to users and stakeholders are a valuable component of this dimension.
- Educational – the capacity of human resources to utilize the system optimally is of interest, as this influences the system’s performance and the quality of service. These factors are intended to identify the training needs.
- Administrative – these factors examine the quality of the administrative processes relating to the system and resulting from the system. This also includes the investment decisions relating to the system.
- Technical – the usefulness of the technologies and their standards are studied to ensure that the technology provides added value and adheres to recommended standards. The standards of interest will regulate the areas of interoperability, communication and functionality.
- Social – the effects on social behaviors are studied; the purpose is to establish the changes in interaction and determine whether these changes are positive or negative.

- + – these are additional factors that are not categorized in the preceding but need to be monitored as well. These include legal, political and cultural considerations.

The components of the CHEATS+ evaluation tool are presented in Figure 8.

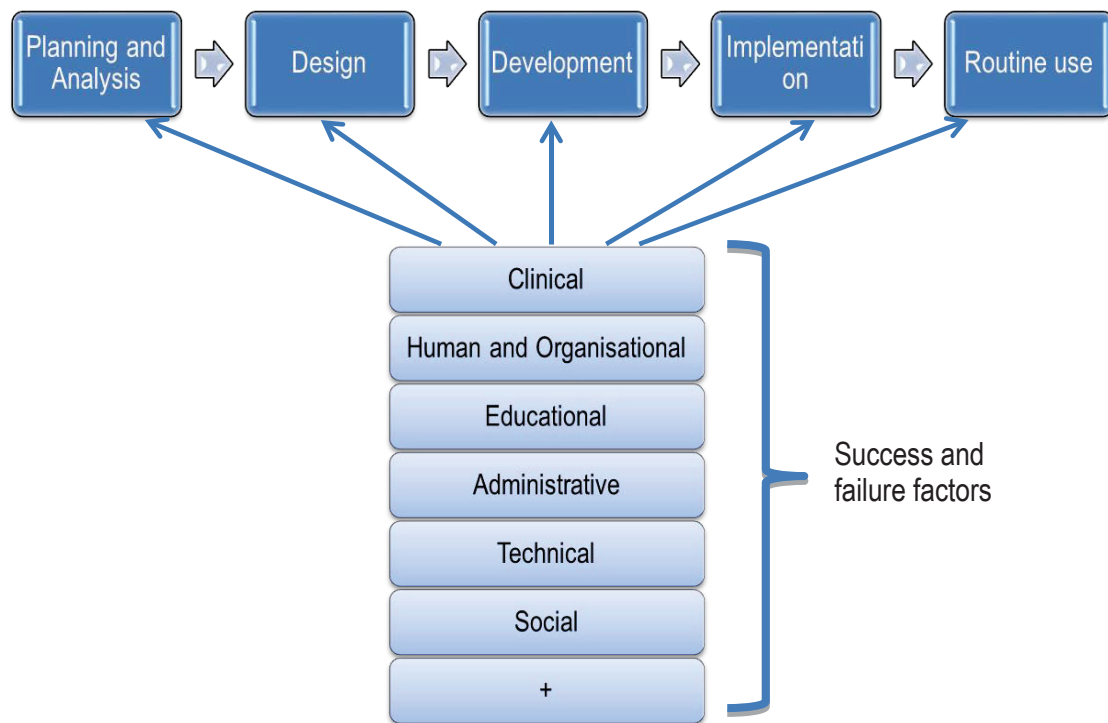


Figure 8 The components of the CHEATS+ evaluation tool

The CHEATS+ factors were then sorted based on their relevance to the following system lifecycle phases.

- Planning and Analysis
- Design
- Development
- Implementation

- Routine Use

Their importance to the lifecycle stages was determined by the result expected when the principle is applied. The impact of each principle on the system's development and implementation was also considered in these assignments.

These resultant factors, found in Table 7-11, are provided as guiding principles and identify the areas of focus for each phase. The relevance of these factors can be confirmed by some of the factors present in the successfully deployed BHIS. These factors include:

- Consistent political support
- Funding and support of international partners
- Evolution of system functionality
- Local adoption
- System fit to the local culture
- Use of implementers with experience

Planning & analysis

Clinical

- Addresses areas of health with the most impact
- The solution is viewed as a service and not a product
- Improvement or addition in health services provided

Human and organizational

- Has simple functionality to meet the user's needs
- The changes within the organization, as a result of the system, are minimal
- Change process is an underlying principle in the system's implementation
- There is positive attitude, engagement and the commitment of users, managers and other stakeholders
- The goals of all stakeholders are managed through processes of compromise, trade-offs and agreement
- The users are acknowledged as central to the system's development

Educational

- The leaders and populace are aware of the need for and benefits of the system
- There is sharing of knowledge across institutions, nationally and internationally on useful models

Administrative

- The system is a part of the health sector strategy
- Goals for the system have been established, with milestones for tracking
- The factors to determine the return on investment are clear
- Deadlines and plans are flexible
- The development strategy demonstrates a connection between development initiatives
- There is sufficient funding for implementation and maintenance
- Decision-making policy ensures merit-based actions
- Timelines are realistic

Technical

- Requirements include the needs and demands of users and stakeholders
- The development strategy details the operational phase and how the system will continue to evolve

Social

- The social context of the system is understood

+

- There is preparedness and willingness to adopt the system as part of the local healthcare system (institutionally and population-wide)
- There is readiness for changes to the current healthcare model
- A national strategy exists to support the development efforts
- The strategic plan includes approaches for all levels of the national health infrastructure
- There is evidence of the support and commitment of political leaders and institutions
- There is a national and (or) international willingness to invest
- Funding provided without preconditions for utilization of a particular process, tool, system, or vendor; the best-fit solution can be chosen

Table 7 Planning and analysis factors

Design

Clinical

- The solution is viewed as a service and not a product
- Standards are met for clinical guidelines

Human and organizational

- Design is based on principles of health services
- Can adapt to changes
- The design process begins with an interpretation of the current workflow
- How people relate to each other in terms of the workflow and teamwork is considered when adding new processes
- The goals of all stakeholders are managed through processes of compromise, trade-offs and agreement
- The users are acknowledged as central to the system's development

Educational

- There is sharing of knowledge across institutions, nationally and internationally on useful models

Administrative

Technical

- Components will be integrated
- Components will be interoperable
- Data processes are designed to ensure data validity

Social

- The requirements for social aspects of the system are understood

+

- The system fits the local culture (norms)
- The legal requirements are known, along with the challenges and opportunities these may bring
- The reactions within the political circles are known and catered to

Table 8

Design factors

Development

Clinical

- The solution is viewed as a service and not a product

Human and organizational

- There is collaboration and cooperation among health system stakeholders and system developers, including health experts
- Feedback is provided to the developers regularly
- Developers and stakeholders build relationships with trust and good intent
- Users are involved in the development process and concessions are made to allow them to do so
- There is positive attitude, engagement and the commitment of users, managers and other stakeholders
- The goals of all stakeholders are managed through processes of compromise, trade-offs and agreement
- The system is promoted to encourage adoption

Educational

- Developers, implementers and stakeholder groups include individuals with experience in developing and deploying similar solutions
- There is sharing of knowledge across institutions, nationally and internationally on useful models

Administrative

- The following management principles are applied: effective communication, delegation, cooperation, coordination, risk management, budget controls, responsiveness and input from lower levels
- Communication roles and protocols are defined
- Information is readily available
- There is accountability for budgetary increases

Technical

- Incremental changes are allowed, but the system is not held in a pattern of continuous development
- The system evolves or is extended over time
- Relevant technology and communication standards are used
- The technology that is being utilized boasts a positive track record
- There is stepwise progression in extending the technological capabilities of the system

Social

- Functionalities reflect the social realities

+

- The processes relating to development can be observed and scrutinized
- The Ministry of Health is committed to the development of the system even if it is not the initiator of the development process
- The legal requirements are known, along with the challenges and opportunities these may bring
- The reactions within the political circles are known and catered to
- There is evidence of support from higher institutions (regional and international)

Table 9 Development factors

Implementation

Clinical

- Fulfills requirements for health impact
- Improvement or addition in health services provided

Human and organizational

- Users' cognitive processes are not disrupted
- The value or benefits for utilizing the system is known by users, stakeholders and the populace
- There is no ambiguity in the implementation process, partners are able to monitor and discuss the specifics of all activities
- Users are willing to adopt new procedures
- There is an awareness that system implementation is not a clear cut process
- Constructive feedback is provided to address system inadequacies
- Changes in procedures and services are effected in a stepwise progression and not all at once
- Change management is guided by specialists
- There is user acceptance of the system
- The system is promoted to encourage adoption

Educational

- Users are trained to enable use of the system for daily tasks
- Training enables users to know the boundaries of the system and also the opportunities that it provides

Administrative

- There is sufficient funding for implementation and maintenance

Technical

- The system is promoted to encourage adoption
- Components are integrated
- Components are interoperable
- System is flexible to accommodate changes while being consistent in its operation
- The system meets usability standards

Social

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- The legal requirements are known, along with the challenges and opportunities these may bring
- The reactions within the political circles are known and catered to

Table 10 Implementation factors

Routine Use

Clinical

- The health outcomes are positive
- There is improvement in the quality of care
- Results are evident in the areas of impact

Human and organizational

- The system meets the expectations of the context- internal workflows, internal and external reporting requirements, and communication links between institutions or organizations
- The system has been adopted as part of the culture

Educational

- Users are trained to enable use of the system for daily tasks
- Training enables users to know the boundaries of the system and also the opportunities that it provides

Administrative

- There is a return on investment
- Strategic goals have been met

Technical

- Fulfills the needs and requirements of users and stakeholders
- The system helps the user to complete daily tasks; meets the needs of the population when accessing care
- The system can be changed in the future, without affecting its operational capacity
- The system meets standards for usability

Social

- The system does not negatively impact social interactions

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- The system fits the local culture (norms)
- The legal requirements are known, along with the challenges and opportunities these may bring

Table 11 Routine use factors

5.2.3 APPLICABILITY TO THE CARIBBEAN REGION

There are several factors that facilitate the use of the CHEATS+ evaluation tool in the Caribbean region. The small sizes of the countries within the region permit easy oversight of the national iHIS. The use of this approach requires the ability for high level views of the national iHIS, which would be easily achieved. This limited size also enables ease of gathering information to assess the evaluation factors.

The diversity in stages of implementation of iHISs in the region is also significant to the use of this approach. For, while countries like Belize are experiencing routine use of the national iHIS, there are other countries that are currently in the planning phase, while others are in the development or implementation phases. This approach allows each country to adopt and utilise the tool at their respective stages. Therefore, all of the countries can benefit from its guidance on critical factors at each phase.

The limited number of evaluators for iHISs in the Caribbean can be supported by this tool. It can be utilised to identify the focus of evaluations. It saves time by distinguishing the important areas of emphasis for each phase of development and implementation.

5.2.4 APPLYING THE CHEATS+ EVALUATION TOOL

The CHEATS+ evaluation tool is a set of guiding principles for evaluations. The tool establishes the principles of success, and therefore can serve as a guide for evaluating the factors that are necessary for success at each phase. It provides a method for assessing the expected outcomes of each phase, for successful systems.

This evaluation tool, CHEATS+, can be used in stepwise progression and is also useful for iterative development cycles. The critical aspect is that the system's phase is

known. When phases overlap the two related portions of the tool will need to be used. A formative evaluation focus is intended for the initial development stages with a summative evaluation theme in the operational stage. The processes to accomplish an evaluation activity with the CHEATS+ evaluation tool can be outlined as:

- Determine the system phase
- Assemble and elicit stakeholders' needs
- Ascertain evaluation uses and determine priorities from CHEATS+ evaluation tool
- Facilitate choice of methods
- Perform evaluation
- Report results to stakeholders
- Apply results for stakeholder uses and rectify system-related issues if necessary

5.2.5 METHODS

The use of sound research principles, grounded in proven research practices is a quality that should accompany evaluation activities [Chapter 2]. There are no prescribed techniques or combination of such that is stipulated for evaluation studies [79]. The methods that will be considered for use with the CHEATS+ evaluation will include both quantitative and qualitative approaches. It is noted that the assessment of outcomes requires an application of quantitative and qualitative methods and should involve stakeholders at all levels, both locally and externally [13]. Additionally, this is supported by current HISs evaluations, which are focusing on the application of qualitative methods

and an attention to non-technical areas such as human and organizational issues [Chapter 2].

The strengths of both quantitative and qualitative methods support the use of both methods in evaluation of HISs. The multi-method approach provides methods that can adapt to the processes under review and areas of interest over the life of a system [Chapter 2]. It is advocated that a multi-method approach be adopted for the evaluation of national iHISs in the Caribbean region. It not only supports a rigorous examination of factors through triangulation but also enables the evaluation to benefit from the strengths of different methods. This tool is not restricted in the methods that can be utilized, as demonstrated there are no lack in methods to evaluate success or failure factors [Chapter 2].

The adaptation of research methods during evaluations is often necessary because of the impact of environmental factors [79]. The methods that will be used in the evaluation process will be chosen with the input of stakeholders. The evaluator's role would be to facilitate the selection of the method(s) that are most suitable to answer the evaluation questions in the current setting. The significant element is that these methods are applied to attain the highest standards for scientific rigor possible in the setting [79].

5.2.4 VALIDATING THE CHEATS+ EVALUATION TOOL

The validation of the CHEATS+ Evaluation tool has to be achieved in two phases. Phase one will entail an assessment of the tool by experts involved in the development and implementation of iHIS in the Caribbean region. For this step the local and nonresident experts that were involved in the development of the BHIS will be the

participants. A rating scale can be used to determine 1) the relevance of the factors to the respective stages and 2) the relevance of the factors to the development and implementation of iHIS in Caribbean context. To achieve these outcomes a Delphi study can be used. The challenge for the researcher would be to facilitate the presence of both local and overseas experts for consensus. To resolve this, the options would include facilitating a virtual meeting or conducting the study in two phases, once for local experts and the other for overseas experts.

The second phase would entail validating the CHEATS+ factors through an assessment of the BHIS. A qualitative study involving document reviews and interviews can be applied to achieve these outcomes. The interest in this phase is to validate the presence or absence of these factors throughout the development and implementation of the BHIS. To make this process manageable, the goal should be to identify the factors that were present in the phases, since validating each of the factors individually would require extensive time and human resources. The measurement criteria for validation would be the presence of at least 50% of the factors in each phase.

The validation of the CHEATS+ evaluation tool will also be accomplished through use of the tool with other systems in the Caribbean region. This however, would be the result of long-term work, which will include tracking a system's progress through all of the phases, then assessing the presence or absence of factors and whether the system succeeded or failed.

5.2.5 LIMITATIONS OF THE CHEATS+ EVALUATION TOOL

The CHEATS+ evaluation tool has not been validated although methods to accomplish this have been outlined. Prior to the validation efforts the indicators as well as the performance criteria or adequate standards will need to be added to the tool. These will establish the qualities for measurement and the degree to which the quality must be present. The methodologies for measuring these qualities are also to be defined. These elements are also components of an evaluation plan, a guide that requires much more time than can be afforded at the Master's level of study.

The CHEATS+ evaluation can benefit from a reduction in the factors of focus at the different phases. A useful process for accomplishing this would be to refine the factors based on the emphasis of the BHIS as this is the reference model. This would involve decreasing the factors to specify those that are related to the principles of individual health outcomes, public health performance and resource utilization.

5.3 CONTEXTUAL CONSIDERATIONS FOR REGIONAL EVALUATIONS

In performing evaluations there has to be knowledge of and an accompanying plan to manage the effects of contingent factors [Chapter 2]. An evaluation approach for national iHISs in this region will need to consider a number of key issues: the population context, stakeholders, the integration effect and sustainability.

5.3.1 POPULATION CONTEXT

One of the goals for the national iHIS is to improve the quality of health services provided. The emphasis on population health implies a need to evaluate health outcomes

as a part of its evaluation. This investigation of health outcomes should consider the administrative structure of the national health system and the geographical differences of the population. The decentralized model of health systems unaccompanied by the management of social and political factors can affect the quality of health and information services [23]. Therefore, an evaluation at the top level to gain insights about population health outcomes has to be accompanied by monitoring of the lower levels. This would enable recognition of possible threats to data accuracy. Further, the dispersion of the population across rural and urban areas and the resultant effect on health services must be considered.

In assessing the effectiveness of HISs, the aim should be to address inequities in care and to enable provision of services to vulnerable groups [9]. To facilitate examination of the effects across diverse communities, it is recommended that evaluations be tailored to gain insight into the benefits or harms in local communities. Performing evaluations that capture insights from the locality are valuable for assessing progress or difficulties, along with benefits or harms. Therefore, the evaluations should not be based on national estimates but should entail examination of effects at the local levels. The qualitative methods would be useful for these purposes of capturing the effect with an understanding of the local context.

The performance of HMN assessments can be referenced in comparison. Because of its method of national review, it does not capture details of access, equity or geography. As a result, it is not possible to perform comparisons of effect in diverse settings, e.g. rural vs. urban. While the HMN assessment seeks the overall status it does not inform on

experiences with the system at different points, and how quality of care is impacted in specific local areas.

5.3.2 STAKEHOLDER RESPONSIBILITIES

The reality that a) the number of factors to be evaluated is extensive and b) the resources are oftentimes limited indicates that prioritization is necessary. Prioritization is relevant for the selection of the most important areas for review. National priorities may change or vary and countries should be able to decide on the most pertinent factors to be evaluated. The contribution of stakeholders is a defining attribute of evaluations [Chapter 2]. The stakeholders are valuable for deciding the focus of the evaluation. In creating an evaluation it is important to determine what questions are the most crucial for determining the system's value in that case [41]; intended users and stakeholders are valuable informants in this regard and can aid in identifying the pertinent issues. As users, donors and policymakers, their perspectives provide insight to important evaluation areas. Ideally, because the populations are primary beneficiaries of iHIS use the areas of importance should be sourced from them. However, the input of other groups of stakeholders can be taken to represent the interests of the population.

The regional stakeholders are found locally, regionally (CARICOM) and internationally (WHO). Sometimes the term stakeholder adds obscurity to these individuals but the personality of stakeholders has to be acknowledged. Stakeholders are the 'real, live, caring human beings,' [80] that determine the impact of an evaluation.

The roles of stakeholders in the evaluation procedures include but are not limited to those of funding, collaboration and utilization. As project funders, their responsibilities

should include providing financial support in project allotments for evaluation activities and insisting on evaluation activities being a component of the project plan [37]. Their role would be extended in this regard to ensuring that the planned evaluations are done. Although in an evaluation of success there are different factors that are important to different stakeholders [82] through collaboration the major concerns can be identified and evaluated. The collaboration of stakeholders locally and internationally is critical to the performance of evaluations in the Caribbean because of the major role of international stakeholders, such as health sector donors.

It is useful to consider the resulting impact of an assessment activity. For a group of policy stakeholders within the Caribbean region the specific uses of an iHIS evaluation can vary from learning to reporting. Some of these specific uses are noted in Table 12.

Evaluation Roles	Specific uses
Formative	Reporting progress
Summative	Declaring success or failure; Cost-effectiveness
Understanding	Informing actions
Dissemination	Evidence for policymakers and donors

Table 12 Evaluation uses by stakeholders
Adapted from the CIPP Model for Evaluation [83]

Improving the use of evaluation results by stakeholders within the region to impact development is important to the success of national iHISs. This cannot be achieved if the product of an evaluation is not accessed or applied to guide improvement. For this purpose a utilization-focused approach is invaluable. This will support the facilitation of an evaluation process to achieve results that will be used meaningfully. The premise is

that when intended users are included in the evaluation process, this provides considerable support for achieving use of the evaluation results upon completion [80]. The participation of the intended users gives them an opportunity to contribute to the process and understand its value [80].

Utilization-focused evaluation extends the utility standard of evaluation beyond providing users with information to understanding how specific details will be applied. The concept of utilization-focused evaluation requires consideration of how potential users will apply the findings in real-life activities [80]. It conveys an interest in the relevance of the results to the user’s experience. While this appears reminiscent of qualitative theory, the utilization-focused approach is not dependent on the use of a particular theory or method [80]. This affirms that the roles of an evaluation as either a formative, summative, understanding or dissemination activity can be fulfilled through use of this approach.

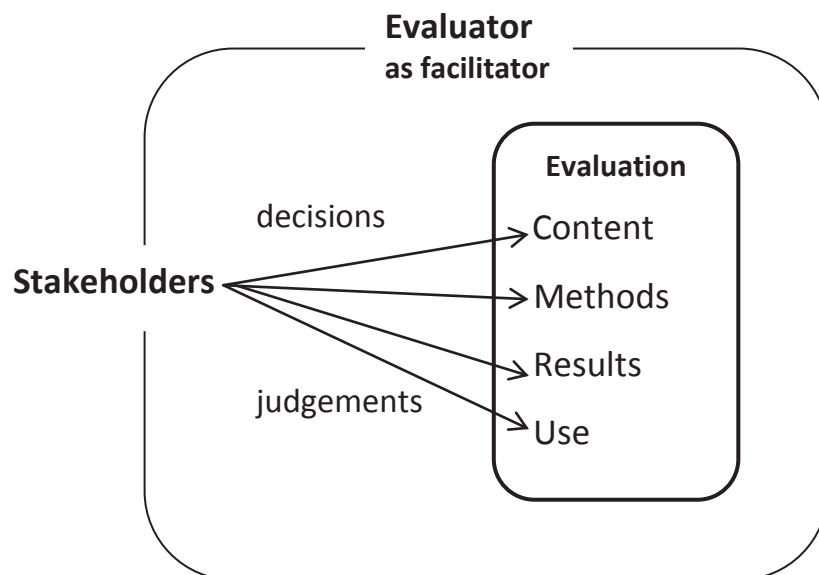


Figure 9 The utilization-focused evaluation approach [80]

The application of this approach will enable actual users, as primary stakeholders, to participate in the decision-making and conclusions about the evaluation content, method, and use [80]; (see Figure: 9). The duties of the evaluator are primarily that of facilitator; providing guidance and support to the stakeholders as they work through the evaluation details. It is a suitable method to engender participation and use of the evaluation results by stakeholders and users.

5.3.3 INTEGRATION

The underlying reason for evaluating the iHIS is to provide indications of how well the system as a complex entity performs to support the goals of healthcare. Because the IS is not limited to the technical components of the system, this evaluative approach can be described as one for an “IT-based solution,” [28]. This means that it includes aspects of the organisational environment, and socio-technical components such as the culture, workflows, stakeholders, and political and economic factors [28]. The inclusive approach is proposed because the results based on one portion of a system should not be used to generalize and inform decisions for the wider system [28]. The recognition that the whole is greater than the sum of its parts is applicable in the case of IS. The evaluation of integration with the inclusion of technical, social, and organisational factors would have to address:

Technical – the arrangement of the components

- What is the effect of the technical structure on efficiency and effectiveness?
- What is the level of integration (full or partial)?
- Does the integration approach utilise technical best practices?

- What are the benefits of integration?

Health Outcomes – the impact of a continuum in the delivery of care

- How is patient-care coordinated?
- Does the patient benefit from the continuity in care?
- How does the continuity of care support improvements in health outcomes?

Social & Organisational Outcomes – the effects on internal processes and external processes

- Is the workflow between components improved?
- How is the workflow coordinated between decentralised locations?
- What are the effects on interactions with the patient?
- What is the effect on the patient's experience?

5.3.4 SUSTAINABILITY

Sustainability has been identified as an area of interest for developing country systems [Chapter 4]. The evaluation should explore the options for sustainability in systems with information sharing capability [20]. These are considered in enquiries as:

- Has the system been adopted locally?
 - What are the factors that will promote sustainability?
 - Can this infrastructure be sustained? Are there reusable, extendable components?
- Is there adequate human resources capacity?

5.4 SUMMARY TO CHAPTER 5 AND TRANSITION TO CHAPTER 6

This section presented the CHEATS+ evaluation tool as a set of guiding principles for iHIS evaluations. It is intended to support the objectives for evaluations of iHIS in the Caribbean. While its use may not be limited to the Caribbean region, there are several factors that affirm its relevance to the current regional setting. Also proposed were contextual considerations that should define the methodology for evaluations in the region. In the following section the research questions will be examined to affirm the conclusions of this work and highlight the contributions to this field of study.

CHAPTER 6 CONCLUSION

6.1 CONCLUSIONS

This work utilized the existing literature and addressed the following research questions.

1. What are the features of national iHISs?

- i. HIS are implemented to foster improvements in data-related as well as management processes. While the emphasis is on information management, there is also a considerable influence from an aspiration to positively impact the patient-care delivery process. As a result, while technology has been important and its benefits acknowledged, it has not been the central theme. The value of streamlined data processes is evident as this is the basis for application of technology.
- ii. The components of the iHIS addresses both institutional and population health data sources. The population approach requires integration of national data sources. While at the institutional level, the electronic patient record requires integration of multiple health sector services.
- iii. Integration is a strategic issue. It involves the fusion of policies, perspectives, infrastructure and stakeholders. One of the primary aims of integration is to enable information sharing. The methods to accomplish this vary across countries. This has prompted discussions about the role of governments in enabling integration. The role of governments can be fulfilled through policymaking, funding, legislation or standards-development.

- iv. The BHIS has enabled the Belizean Ministry of Health to effect programs and procedures that yield benefits for the local health system. The values of improved outcomes, performance and utilization are useful for other national iHISs. The integration model relies on the coupling of functionalities and connection of data sources. Evidence of benefits can influence the use of specific approaches, so a deliberation of the pros and cons for each country will determine the implementation model.

2. How should the evaluation of HISs be performed?

- i. An evaluation is an activity whose intent is to provide answers that can be used to inform decisions. Therefore the reason for an evaluation is important to its description. The presence of stakeholders is a defining characteristic of evaluations but does not diminish the activity's emphasis on research related and scientific approaches. The evaluation of HISs are being influenced by the use of qualitative methods and an interest in human and organizational issues.
- ii. The challenges accompanying the performance of evaluations are numerous. This indicates that performing evaluations of HISs require the ability to adapt to the circumstances. The management of technical, human and environmental factors is required to enable the best possible assessment in the particular conditions.
- iii. Evaluations should be planned for the duration of the implementation process. The formative and summative evaluation approaches provide answers to different inquiries and therefore are both useful for the

evaluation of HISs. The formative evaluation provides an assessment of the implementation as it progresses, while the summative evaluation focuses on the end-product, to demonstrate whether the goals of the implementation were met.

- iv. The evaluation of HISs has to consider the technical as well as the non-technical factors. Social and organizational features are also influential to the system's performance and as a result their role has to be examined. The evaluator and stakeholders contribute their assumptions and interests to an evaluation and this also affects the focus of the evaluation. The focus of an evaluation is further influenced by the national context as priorities may vary from country to country.
- v. Quantitative and qualitative methods should be applied in the evaluation of HISs. The quantitative methods provide the techniques to support analysis of discrete elements while the qualitative methods are useful because of their ability to provide insights about the setting.
- vi. The multi-method approach provides the mechanism for evaluating the changing priorities of a system during implementation. The usefulness of each method should be utilized to benefit the examination of the specific area under study.

3. What are the available frameworks that can be applied for the evaluation of HISs?

- i. The strength of the D&M IS Success model is in the relational connections among its components. Its weakness in addressing the organizational effects prompts efforts to extend it.
- ii. As an advanced model of the D&M IS Success Model, the Canada Health Infoway Benefits Evaluation Framework includes a crucial component – net benefits. The challenge for this framework is to extend the areas of focus without losing the ease of its use.
- iii. The HMN assessment tool enables a comprehensive review of the components of national HISs. The inclusion of a wide range of stakeholders in the evaluation process is an important accomplishment. However, the extensive list of indicators and the time required to complete the evaluation are limitations to its consistent use.
- iv. The CHEATS evaluation framework addresses the factors that should be included in the evaluation of health ICT. It allows the evaluation of a set of general factors. A review of the factors is needed to specify the areas of inclusion more clearly.
- v. The strength of the Balanced Scorecard in assessing strategic value is evident. It would be useful in areas relating to healthcare strategy but its application in other healthcare areas is not proven.
- vi. The Vital Wave staging approach builds on the conditions existing in HISs development in developing countries. This progressive outline provides benchmarks for achievement and descriptors for system attributes at each stage. It is useful for evaluating progress and envisioning next steps.

- vii. The PRISM set of evaluation tools are useful for monitoring the performance of the organization. The focus on internal processes and factors is relevant but limited. The system's evaluation should also account for its performance in its operating environment, external factors.
- viii. The perspective of the framework determines its usefulness in one context or another. There is no single framework to satisfy every perspective. The objective of the evaluation must be established as this will influence the framework chosen. This underscores the necessity of a contextually relevant approach for every environment. Not all evaluation methodologies utilize existing frameworks; in some instances an evaluation approach is specifically developed, acknowledging the interests of stakeholders.

4. What is the evaluation approach that should be applied for evaluating the iHIS in this regional (Caribbean) context?

- i. The evaluation of HISs in the Caribbean are not routinely performed. The evaluation of HISs in the region will enable stakeholders, policymakers and citizens to examine the performance of current systems. Evaluations will provide information to support actions for improvement.
- ii. The success and failure factors provide a list of qualities that can be applied to evaluate the success or failure of a HIS from several operational standpoints. The methods applied for assessing these factors can be selected on their proficiency in providing answers about the area of focus.

There is no lack of methods to address most of the areas of success or failure.

- iii. The CHEATS+ evaluation tool provides the assortment of factors to be considered in evaluating HISs. The CHEATS+ evaluation tool utilizes the principles of the CHEATS framework [56] as an inclusive perspective for HISs; the success and failure factors [81] as a list of qualities; and the lifecycle evaluation plan [28, 32] as a scheduling method. It provides the guiding principles for evaluations by identifying the factors necessary for success.
- iv. The applicability of the CHEATS+ evaluation tool is supported by the geographical sizes of the countries, the different phases of implementation evident across the region and the limited resources available for the evaluation activity.
- v. The CHEATS+ evaluation tool embraces the principles of multi-method evaluations. The methods that will be considered for use with the CHEATS+ evaluation will include both quantitative and qualitative approaches.
- vi. The CHEATS+ evaluation tool has not been validated and can benefit from the specification of measurements and methods. Also appropriate would be a reduction in the factors of focus at the different life cycle phases.

- vii. An evaluation approach for national iHISs in this region will need to consider a number of key issues: the population context, stakeholders, the integration effect and sustainability.

6.2 CONTRIBUTION OF STUDY

The result of this work is an evaluation approach that can be applied for evaluating iHISs in the Caribbean region. The principles for evaluation as well as contextual considerations have been applied to formulate this recommended approach. In addition to extending the dimensions of the CHEATS [56] framework, with an extensive list of factors for evaluations, the recommendations and CHEATS+ evaluation tool contribute to knowledge for evaluations within the Caribbean region and in other areas with a similar profile.

6.3 FUTURE WORK

This work provides the foundation for evaluation activities for iHIS in the Caribbean. It forms the basis for potential evaluation activities in the region by the author. The future activities include validating and utilising the tool. For utilization of the CHEATS+ evaluation tool, the tasks relating to validation will be a priority followed by the development of an evaluation plan as outlined in Chapter 5. Insights gained from experience within the region will be valuable for refining the CHEATS+ evaluation tool. This will enable the formulation of a tool that is sensitive to the region. Consequently, updates to the tool will concentrate on its application within the Caribbean.

Other activities include providing adaptations to the CHEATS+ evaluation tool for Personal Health Record components. It is anticipated that efforts to begin the use of Personal Health Records within the region will be initiated shortly. This will require an assessment of the effect of this component on current evaluation measures. The CHEATS+ evaluation tool will have to be updated to reflect these changes.

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**APPENDIX A WORLD BANK CLASSIFICATION OF ECONOMIES,
JULY 2011**

Country	Economic classification
Antigua and Barbuda	Upper middle income
Argentina	Upper middle income
Barbados	High income
Belize	Lower middle income
Bolivia	Lower middle income
Brazil	Upper middle income
Chile	Upper middle income
Colombia	Upper middle income
Costa Rica	Upper middle income
Cuba	Upper middle income
Dominica	Upper middle income
Dominican Republic	Upper middle income
Ecuador	Upper middle income
El Salvador	Lower middle income
Grenada	Upper middle income
Guatemala	Lower middle income
Guyana	Lower middle income
Haiti	Low income
Honduras	Lower middle income
Jamaica	Upper middle income
Mexico	Upper middle income
Nicaragua	Lower middle income
Panama	Upper middle income
Paraguay	Lower middle income
Peru	Upper middle income
St. Kitts and Nevis	Upper middle income
St. Lucia	Upper middle income
St. Vincent and the Grenadines	Upper middle income
Suriname	Upper middle income
Trinidad	High income
Uruguay	Upper middle income
Venezuela, RB	Upper middle income

Table 13 World Bank classification of economies, July 2011 [85]

APPENDIX B MAPPING OF SUCCESS AND FAILURE FACTORS

Category of factors	Evaluation focus
Functional	<ul style="list-style-type: none"> - Requirements include the needs and demands of users and stakeholders - Fulfills the needs and requirements of users and stakeholders - Incremental changes are allowed, but the system is not held in a pattern of continuous updates - The system helps the user to complete daily tasks; meets the needs of the population when accessing care - The system meets the expectations of the context- internal workflows, internal and external reporting requirements, and communication links between institutions/ organizations - Design is based on principles of health services - The requirements for social aspects of the system are understood - Users' cognitive processes are not disrupted - Addresses areas of health with the most impact - Has simple functionality to meet the user's needs - The system evolves or is extended over time - Can adapt to changes - Improvement or addition in health services provided - The value or benefits for utilizing the system is known by users, stakeholders and the populace
Organizational	<ul style="list-style-type: none"> - There is collaboration and cooperation among health system stakeholders and system developers - Feedback is provided to the developers regularly - Developers and stakeholders build relationships with trust and good intent - There is no ambiguity in the implementation process, partners are able to monitor and discuss the specifics of all activities - The design process begins with an interpretation of the current workflow - How people relate to each other in terms of the workflow and teamwork is considered when adding new processes - The changes within the organization, as a result of the system, are minimal - Users are willing to adopt new procedures - Developers, implementers and stakeholder groups include individuals with experience in developing and deploying similar solutions - There is evidence of support from higher institutions [regional and international]
Behavioral	<ul style="list-style-type: none"> - The users are acknowledged as central to the system's development - There is positive attitude, engagement and the commitment of users, managers and other stakeholders - The system is promoted to encourage adoption
Cultural	<ul style="list-style-type: none"> - The system fits the local culture [norms] - There is preparedness and willingness to adopt the system as part of the local healthcare system [institutionally and population-wide] - There is readiness for changes to the current healthcare model
Political	<ul style="list-style-type: none"> - A national strategy exists to support the development efforts - There is evidence of the support and commitment of political leaders and institutions - The leaders and populace are aware of the need for and benefits of the system - There is a national and /or international willingness to invest - Funding provided without preconditions for utilization of a particular process, tool

Category of factors	Evaluation focus
	<p>system, or vendor; the best-fit solution can be chosen</p> <ul style="list-style-type: none"> - Manage the shifts that result in the political environment - The solution is viewed as a service and not a product - There is sharing of knowledge across institutions, nationally and internationally on useful models - The processes relating to development can be observed and scrutinized
Management	<ul style="list-style-type: none"> - The system is a part of the health sector strategy - The Ministry of Health is committed to the development of the system even if it is not the initiator of the development process - Goals for the system have been established , with milestones for tracking - The factors to determine the return on investment are clear - Decision-making policy ensures merit-based actions - Deadlines and plans are flexible - Timelines are realistic - There is an awareness that system implementation is not a clear cut process - Constructive feedback is provided to address system inadequacies - The following management principles are applied: effective communication, delegation, cooperation, coordination, risk management, budget controls, responsiveness and input from lower levels - Change process is an underlying principle in the system's implementation - Changes in procedures and services are effected in a stepwise progression and not all at once - Change management is guided by specialists - Users are involved in the development process and concessions are made to allow them to do so - The development strategy details the operational phase and how the system will continue to evolve - The development strategy demonstrates a connection between development initiatives - Communication roles and protocols are defined - Information is readily available - The goals of all stakeholders are managed through processes of compromise, trade-offs and agreement
Technical	<ul style="list-style-type: none"> - Relevant technology and communication standards are used - Data processes are designed to ensure data validity - The technology that is being utilized boasts a positive track record - The system meets standards for usability - Components are integrated - Components are interoperable - System is flexible to accommodate changes while being consistent in its operation - Applying technological solutions is done in stepwise progression and not all at once - The system can be changed in the future, without affecting its operational capacity
Legal	<ul style="list-style-type: none"> - The legal requirements are known, along with the challenges and opportunities these may bring
Strategy	<ul style="list-style-type: none"> - The strategic plan includes approaches for all levels of the national health infrastructure
Economy	<ul style="list-style-type: none"> - There is a return on investment

Category of factors	Evaluation focus
	<ul style="list-style-type: none"> - There is accountability for budgetary increases - There is sufficient funding for implementation and maintenance
Education	<ul style="list-style-type: none"> - Users are trained to enable use of the system for daily tasks - Training enables users to know the boundaries of the system and also the opportunities that it provides
User acceptance	<ul style="list-style-type: none"> - There is user acceptance of the system

Table 14 Mapping of success and failure factors [81]