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## Health Information Systems – Opportunities and Challenges in a Global Health Ecosystem

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### Abstract

Health Information Systems (HIS) and Health Information Technology (HIT) have experienced significant growth in use and improved functionality in recent years. The global HIS/HIT market is estimated to grow exponentially in value by 2020. This growth in market size is largely attributable to three key factors: 1) the need for disruptive solutions to challenge the spiraling cost of healthcare, 2) the increased penetration into new markets of healthcare related systems, and 3) the increasing demand for personalized medicine driven by the availability of novel, real-time data streams not previously experienced in the healthcare domain. This short article explores these three aspects of HIS/HIT. In order to achieve meaningful advances in people's health through the provision of new technologies, a more integrated and holistic approach is needed in the design and implementation of HIS. The increasing costs of healthcare coupled with the heightened expectations of stakeholders continues to place increasing pressure on those tasked with delivering new health technologies that are 'fit for purpose' in respective healthcare settings. More attention needs to be given to understanding the cost of healthcare and how HIS/HIT may create value in healthcare services.

**Keywords:** health information systems (HIS), health information technology (HIT), decision support, real-time data, cost, maturity

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## **1. Introduction**

The healthcare sector is complex. The criticality of the provision of healthcare services is compounded by the variety and number of stakeholders involved in supporting the delivery of health services from the community to hospitals settings. More recently, Health Information Systems (HIS) components such as electronic health records (EHRs) also referred to as electronic medical records (EMRs) have become more widely implemented. Some comparisons may be drawn between EHR systems and enterprise resource planning (ERP) systems and the markets in which they operate (Gruman, 2014). EHR systems provide a unified single view of patient data. ERPs and CRMs provide a unified view of the customers, manufacturing, procurement, and financial data in industries such as manufacturing, retail and financial services. While ERPs are now largely considered standard software solutions in these industries, it is only in the last 5 to 7 years that EHR systems have become the cornerstone of national digital health strategies. Interestingly much like the ERP industry where software vendors such as SAP and Oracle dominate the market, the EHR software industry has experienced a similar phenomenon with healthcare organizations increasingly relying on a small number of EHR system vendors including Cerner and Meditech (Gruman, 2014). Further analogies could be drawn between EHR systems and ERPs, most importantly it is crucial to consider the fundamental lessons learned from the unsuccessful ERP implementations resulting from issues around customization, integration, and digitization (Snyder, 2010).

The priority for implementing HIS in healthcare settings is squarely focused on improving the delivery of healthcare services and positively impacting patient health outcomes. In order to consider the opportunities and challenges for HIS, it is useful to explore HIS in terms of the cost of providing high quality healthcare services, within the context of a maturing HIS area and finally by understanding and beginning to address the health data need among the many stakeholders that operate in this domain.

## **2. Cost of Healthcare**

The cost of providing healthcare continues to grow in developed and developing countries (Willis Towers Watson, 2017). This growing cost is being driven by an aging population, a growing prevalence in chronic diseases and comorbidities and heightened patient expectations of the health services (Deloitte, 2017; Kaplan and Porter, 2011). According to a recent Deloitte report (2017) it has become more difficult to support the provision of public healthcare systems at the current service levels. Governments internationally are coming under increasing pressure to provide quality healthcare services at affordable prices (Deloitte, 2016). However, understanding the true cost of healthcare is complex and stakeholders, including governments, healthcare providers, and healthcare insurers, do not agree on how cost for healthcare services should be calculated (Kaplan and Porter, 2011).

Health information systems (HIS) are perceived as ‘silver bullet’ solutions aimed at creating efficiencies in the healthcare system and subsequently reducing the cost of healthcare (Bates, Saria, Ohno-Machado, Shah, & Escobar, 2014; Chaudhry, Wang, Wu, Maglione, Mojica, Roth, Morton & Shekelle 2006). Indeed, technological innovations are central to understanding how quality healthcare services may be provided in novel ways into the future (Deloitte, 2017). This may be achieved when healthcare providers can find a balance between delivering on high-quality and cost-efficient patient care (Deloitte, 2016).

## **3. Growth of Health Information Systems**

HIS are popular amongst patients, care givers, and healthcare professionals. HIS include system of record technologies such as EHRs, mobile health (mHealth), and electronic health (eHealth) solutions. These technologies operate across the healthcare ecosystem serving different types of stakeholder engagement e.g. clinician-to-patient, clinician-to-clinician, and patient-to-patient. HIS have become increasingly embedded in the delivery of healthcare services resulting in the development of HIS to acquire, store, maintain, and share health related data, providing sophisticated data analysis and decision support to relevant stakeholders.

In their 2016 paper, Carvalho, Rocha, & Abreu undertake a systematic review of maturity models in healthcare information systems. They identify 14 maturity models that vary widely across a number of factors. These include: technological focus e.g. EHR and telemedicine, healthcare scenario, the number of stages in each model, research method and evaluation techniques associated with each model, aspects or factors influencing maturity and the maturity model underpinning the specific healthcare maturity model e.g. Capability Maturity Model (CMM) (Carvalho et al., 2016). Noteworthy, the health IT maturity models considered as part of the study were designed at different levels, some are

maturity models specific to national public healthcare systems such as NHS while others are more specific to healthcare organizations (Carvalho et al., 2016).

While HIS as an area continues to grow and mature, research to date has largely overlooked the big picture necessary to ensure the seamless integration of innovative HIS into the complex global healthcare ecosystem (Ullah, Habib, Farhan, Khalid, Durrani, & Jabbar, 2017). In their investigation of health IT maturity models, Carvalho et al. (2016) elucidate the need for a more complete universal maturity model. They note that “a maturity model with a holistic approach including a comprehensive set of influencing factors is missing” highlighting the opportunity for a more abstracted general model where the various factors could be weighted based on a specific healthcare scenario or context (Carvalho et al., 2016, p131). Technical integration including interoperability is an integral aspect of a number of the existing health IT maturity models (Carvalho et al., 2016). These models include picture archiving and communication systems (PACs) maturity model (PMM) which is specific to process and technology maturity in hospital settings (van de Wetering and Batenburg, 2009) and National E-health Transition Authority of Australia (NEHTA) interoperability maturity model (IMM) based on Capability Maturity Model Integration (CMMI) and a defined set of interoperability goals (NEHTA, 2007).

Given that “integration has been the Holy Grail of management information systems since the early days of computing in organizations” (Kumar and van Hillegersberg, 2000, p.23), there continues to be recommendations that future developments in HIS must move away from vertical silos to horizontally integrated systems that facilitate a standardized and holistic delivery of healthcare across all levels of delivery (Adenuga, Kekwaletswe, & Coleman, 2015; Carvalho et al., 2016). Indeed, this Special Issue calls for research papers that investigate unique challenges and opportunities for Information Systems (IS) integration in the healthcare domain. More specifically, the focus is on the examination of the role of IT/IS in a communication process of collaborative work environment (Angst, Devaraj, & D'Arcy, 2012).

#### **4. Need for Real-Time Health Data**

The healthcare industry lags behind all other sectors in terms of technology adoption (HIPAA, 2016). However, the availability of sophisticated technologies and subsequently increased availability of higher quality data in other areas such as retail and financial services has created a similar demand in healthcare. Certainly, there is an increasing demand for real-time or near real-time health data among citizens (EU Commission, 2017; Petrides, Tanasijevic, Goonan, Landman, Kantartjis, Bates, & Melanson, 2017). The need for standards around health data quality i.e. timeliness, completeness, availability, and accuracy, is widely understood (Nichols, 2016). The quality of health data is highlighted as integral to patient health outcomes (Hasan and Padman, 2006), the cost of healthcare procedures for healthcare service providers, healthcare insurers and patients (Deloitte, 2016), and the generation of new insights to inform both individual and population health from ‘big health data’ scenarios (Ullah et al., 2017).

Healthcare professionals/clinicians know that data is important. They recognise that data or evidence-based decision making is essential to do their jobs (Evans, 1996). Among skilled healthcare professionals clinical decision support systems enable improved decision making at the point of patient care (Castaneda et al, 2015). Clinical decision makers need more and better knowledge, model and document-driven DSS. Administrative decision makers need data-driven decision support systems for performance monitoring, reporting, and improved cost control. The administrative side can also benefit from more model-driven decision systems support to improve scheduling and utilization of facilities. For patients, the availability of near real-time updates on their personal health is empowering (Hood and Flores, 2012). Noticeably areas such as glucose monitoring for diabetes patients (Li et al., 2017; NHS Scotland, 2017; Seol, Thompson, Kreider, & Vorderstrasse, 2017) and blood pressure monitoring amongst those experiencing hypertension (Limaye et al., 2017; Ostchega, Zhang, Kit, & Nwankwo, 2017) have received considerable attention in terms of HIS investment to support the collection and analysis of patient data leading to self and/or personalized medical interventions.

#### **5. Summary and Recommendations**

The growth in HIS/HIT has not been without challenges. The lack of integration across HIS globally is a serious roadblock to embedding these technologies as part of clinical/medical professional practice from primary healthcare to tertiary settings. In their mHealth Green Paper, the European Commission (2012) outlines a number of these obstacles, including: the wide range of health applications available which makes choice difficult, a lack of evidence and quality control regarding their safety and cost-effectiveness, a lack of interoperability between solutions, a lack of processes/infrastructure for prescribing health applications, a lack of professional guidelines for technology use, malpractice liability concerns, data privacy and security concerns, a lack of reimbursement models for remote care by physicians/healthcare professionals or for self-care, a lack of reimbursement for patients’ purchases of applications and wearable devices.

While there has been an explosion of health technologies, for the most part these have been developed in silos (Wicklund,

2015). Health professionals recognise the value in capturing, storing, analysing, and visualising patient health data and the ‘big health data’ opportunity for both individual and population patient health resulting from HIS/HIT. Yet, given the vast number of health apps and other health information systems (HIS), such as EHR systems, and the diversity of approaches in developing health technologies, the global healthcare sector continues to produce heterogeneous, diverse, and huge volumes of data (Chen, Chiang, & Storey, 2012; Ullah et al., 2017).

Healthcare organisations need to develop strategies for prioritizing HIS projects based on clearly articulated explicit patient health requirements and organizational data needs. These organisations need to pursue a more holistic and integrated approach to HIS that enables them to select, design, and implement systems that fulfill well-defined objectives directly relating to improved patient outcomes and/or improvements in the delivery of patient care. Healthcare researchers should go beyond solely looking at the effectiveness of the existing HIS/HIT types of systems but also look at more advanced Healthcare Collaboration Platforms (such as IBM’s Watson) to improve the overall patient care at an affordable cost. In this Special Issue, E. Fernandez (HIS practitioner) explicitly asserts the need for healthcare providers to better negotiate the balancing act between technical innovation and financial/budgetary constraints.

### **Overview of the contents of this issue**

This issue of the journal includes five traditional research articles, two practitioner papers and one teaching case.

P. Kalgotra, R. Sharda and W. D. Paiva look at patient health history data stored in an Electronic Medical Record system (EMR). They present a healthcare application to compare progression of diseases over time between patients diagnosed with Tobacco Use Disorder (TUD) and non-tobacco users. They conclude that understanding how different diseases develop sequentially in tobacco use patients may help healthcare professionals be more pre-emptive in their actions in predicting and even preventing future diseases.

S. Ghrab, I. Saad, G. Kassel, and F. Gargouri present their theoretical framework for Know-How and Knowing-That cartography as a means of better supporting clinical decision makers. This framework is used as a clinical decision support tool to provide clinicians (doctors and healthcare technicians), staff and other individuals (administrators) with person-specific and process-specific information that is intelligently filtered and presented to clinicians to enhance the early care process of children suffering from motor related diseases.

P. O’Raghallaigh and F. Adam explore existing research in the design of Digitally - Based Change Interventions (DBCIs) and use seminal research to propose a theory based framework for designing DBCI (TFFD). The authors use TFFD to analyse the case of a previously designed digital wellness programme. This case analysis serves to highlight the importance of incorporating a behavioural science approach into DBCI design.

In their study, C. Noteboom, J. Hafner, and A. Wahbeh investigate the nature and characteristics of the unlearning process by physicians who use and interact with new HITs, specifically electronic medical records (EMRs). This paper acknowledges the need for unlearning as part of the organizational change process. “Adjusted unlearning” is proposed as a means of tempering the technological upset that new HIT may cause in healthcare settings such as hospitals.

G. Kenny, Y. O’Connor, E. Eze, and C. Heavin conduct an archival study to provide a comprehensive understanding of the opportunities and challenges facing HIS in Nigeria. This study identifies a dearth of IS focused literature in this area thus identifying a distinct opportunity to leverage existing IS theories to better support a more integrated holistic approach to HIS design, development, and implementation.

Using a multiple case study methodology, S. Wallace and L. Iver explore how Small Physician Practices (SPP) have matured through their use of HIT. This study identifies that factors such as HIT security and Inter-Organizational Integration (IOI) are important and have a significant impact, particularly in terms of user productivity and quality of care.

In his practitioner paper, E. Fernández considers the balance between innovation and investment in IT within the context of a heavily regulated healthcare environment. In his article, Fernández frames the opportunities for innovation in HIT enabling research, discovery, and enhanced healthcare delivery within the context of a US healthcare environment that will continue to experience uncertain and reduced budgets.

Finally, K. Ankem, V. Uppala, and A. Dhawan present a teaching case outlining the analysis, selection, and implementation of an EHR system for educational purposes under the constraints of a n IS department in a higher education setting. Ankem et al. conclude that first-hand experience of the system adds value to the learning experience of the student who otherwise would depend entirely on a more traditional approach to teaching and learning i.e. lecture notes and recommended readings.

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