

**DESIGN AND OPTIMIZATION OF AN INTEROPERABLE HOSPITAL DATABASE
SYSTEM**

(Technical Paper)

**AN INVESTIGATION INTO THE POLITICS OF DISPARITIES IN HOSPITAL
DATABASE SYSTEM DESIGNS**

(STS Paper)

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**On my honor as a University Student, I have neither given nor
received unauthorized aid on this assignment as defined by the Honor
Guidelines for Thesis-Related Assignments**

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Introduction

One of the biggest issues that seems to affect every sector of today's society (particularly in America) has to deal with healthcare. When most people think about issues relating to healthcare, they usually think of political ones, such as the degree to which healthcare should be privatized versus made universal. However, a novel, emerging problem that has been taking over the past one or two decades has to do with the digitization of healthcare. With the advent of interconnected electronic systems in the 1990s, there have been countless innovations in the ways we process and handle massive amounts of data and information. Consequently, there has been an explosion in the amount of data that is now available in the world. These rapid developments in information technology have made its way to the healthcare industry, which is one of the biggest epicenters in terms of the amount of data and information that is at the industry's disposal. To properly store and manage all this information, healthcare institutions have slowly switched from shelves upon shelves of paper records to electronic records. Consequently, led to the rise of electronic healthcare databases and database systems.

In other words, an electronic healthcare database is any structured collection of health-related data (i.e. patient data, hospital employee info, billing, immunizations, etc.) organized for storage, accessibility, and retrieval that is stored digitally in some fashion, like on a central server (Institute of Medicine (US) Committee on Regional Health Data Networks, 1994). Such database types include (but not limited to) electronic medical records (EMRs) and electronic health records (EHRs). One of the immediate benefits of this digitization of healthcare information was the speed and efficiency with which data can be created, updated, and retrieved, without having to spend time sifting through piles and piles of paper. Consequently, there have

been significant strides in the automation and standardization of many clinical and business-related logic and processes associated with healthcare systems. Nonetheless many technical problems still persist.

Technical Description

One of the biggest issues that most people don't think about in regards to databases has to deal with how all this critical and sensitive healthcare data/information (such as patient records) is stored, managed, retrieved, and (most importantly) shared, especially at the level of hospital systems. According to HealthCatalyst, there are a number of issues that currently plague these databases (Cardon, 2018). One is that even though these digital databases have made it somewhat easier to manage data, it does little to erase the fact that there is still an overwhelming amount of raw data; making sense of all this raw data that comes from a variety of sources (lab test results, patient health info, dietary info, employee info etc.), without some form of structure or analytic tools, is quite challenging. Another such issue has to deal with the fact that different hospital systems set up and structure their database systems differently from one another, which negatively impacts sharing of data in a number of different ways. In more technical terms, how a healthcare organization decides to structure its entire database system puts a heavy precedent on numerous different factors/qualities; some of these include security of the files (along with other kinds of associated information and data), quality of the file retrieval system, and efficiency with which these files can be updated.

For this prospectus, I will focus on discussing the overall qualities (including security, efficiency, effectiveness, etc.) of interoperability procedures across disparate hospital systems.

Procedures of interoperability refer to the ease and extent to which two or more disparate applications, components, or database systems can exchange and use each other's data and information. Sharing of hospital data across disparate hospital systems is of course an important challenge to tackle, as there are many instances where sharing is necessary such as, for example, when patients are present at different hospitals, when employees get transferred to different systems, and when sharing vital and necessary data and equipment during extraordinary times, e.g. a pandemic (like the current COVID-19 pandemic). However, depending on how different the hospital database systems are (in terms of its structure, data components, user classes), it can be quite challenging to convert from one database format to another. It's in this conversion process that many critical issues can come up, such as issues with security of file transfers/conversion, ensuring user access privileges are roughly the same across both (or more) systems, issues with data redundancy (which takes up storage space in the system), and so forth. All of these factors in combination add up to the difficulty of achieving interoperability (Bhartiya et al., 2016).

Over the years, there have been many solutions and attempts at improving interoperability (among other factors plaguing such databases) through various research studies and articles. One such example that piqued my (as well as my research advisor's) interest was one where a few Nigerian researchers try to improve the usability of a local hospital database system in Nigeria, and then generalize their findings. In this study, Amaechi et al. found that the current structure was not very conducive to smooth and secure data storage and retrieval among discrete user classes (such as patients, doctors, nurses, administration, etc.)⁸. In their study, they proposed a new, more automated system that they believe concretely define user classes and will

enable more secure data and information upload, retrieval, and updating, providing an entity relationship (ER) diagram for their new proposed system along with corresponding tables.

The aim for my research is as follows: (1) determine whether or not the database information and tables provided by Amaechi et al. (2018) follow the rules of standard normal forms of proper database design using 3NF and BCNF tests (among other yet to be determined methods), (2) upon necessary completion of these standard normalization procedures on these tables for the design of their database, determine whether or not the database is potentially interoperable using guidelines detailed by the research study by Bhartiya et al.³, and (3) develop a web-frame/mockup of a simple mobile/web application that can be used to interface with this database. Such an app could potentially be used by healthcare personnel in places like Nigeria. These aims are for the purpose of improving the interoperability of the proposed healthcare database system.

STS Questions and Frameworks

Regarding the topic of my research and, more generally, interoperability across many different organizations/entities, many interesting queries come up. It's important to ponder the following questions in order to properly contextualize my research goals, and to determine exactly to what extent can my research work be turned into something reasonably actualized and possibly impactful. The first question that came to my mind was why is it that all these different hospital systems (both here in the US and across the globe) don't utilize a similar type format for database systems to facilitate easier and more efficient sharing across all of them? In other words, what are the socio-economic and political factors that drive these differences and

disparities? We are all fully aware that distinct organizations are free to choose whatever database structures they would like, but why would all these organizations not have as much of a stringent interest in using a process unified amongst all of them? In countries like Nigeria (which is the focal point of my research), how receptive would they be to external help (such as from a US institution) and advice on improving interoperability amongst their various hospital systems, without too much intrusion?

Another set of questions that also comes to mind is in regards to how these databases and their sets of users are co-configured. How have these hospital databases changed behaviors of health officials and personnel in hospital settings and how have they changed in response to user input? What did they initially look like and what do these databases look like today? What impacts have they had on the various classes of users who interact with its systems on a daily basis? What are some of the ways that these database systems classify its users (and how does this determine what special privileges and authorization they receive in regards to interacting with such sensitive information). These are also important to consider in order to analyze how these databases have changed over the years and if their users' behaviors have collectively had a generally positive or negative impact on the way healthcare is delivered and managed here in the US and around the world. These questions then lead to more questions about implementing improved interoperability: if a majority of hospital systems somehow decided that they wanted to switch to systems that does facilitate better interoperability amongst all their systems, in what manners and to what extent would it require rationalization and synchronization of disparate entities (i.e. patients, healthcare employees, oversight committees, health bureaucratic officials, etc.) across all these hospital systems?

The last question relating to interoperability ties into the concept of torque, or the idea that large IT systems (and the means by which they classify their users) cause their users to behave in specific ways or manners in order for the systems to work (Bowker & Star, 2000). What are some of the possible consequences that such large scale torque in the healthcare industry can have on every group or person affiliated with it (especially in this country)? This concept can be woven into one of the STS frameworks I intend to utilize to contextualize my research: configuring the user, as detailed by Steve Woolgar in 1991 (Woolgar, 1990), which talks about the ecosystem and exchange of factors that affect user behavior in response to using particular tech. At its crux, this framework deals with the questions I ask above in regards to the mechanisms, factors, and processes underlying how users and the technologies they interact with are co-configured as well as how (one-sidedly speaking) technology impacts or configures its users.

Another framework I intend to use in order to answer the questions I posed about the political and socio-economics underpinnings that are attached to how disparate hospital systems choose how to structure their databases (and how that relates to interoperability) deals with the relationship between technological artifacts and the politics surrounding them, as articulated and debated by Bernward Joerges and Langdon Winner in 1999 and 1980, respectively (Joerges, 1999; Winner, 1980). This framework ponders questions regarding whether or not technology influences politics or if our view of technology is shaped by the political implications we associate with them, which can be used to frame a discussion about what political factors impact and/or are associated with database systems in the healthcare industry and their collective interoperability.

Resources

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