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Healthcare Value Chain and the Impact of Analytics & Business Intelligence (A&BI) Capabilities: A Case Study

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ABSTRACT

This study aims to investigate how the existing healthcare value chain system has significantly been impacted as a result of the increasing adoption and implementation of analytics and business intelligence (A&BI) capabilities. Given the increasing interest and investment in A&BI, it is important to have a good understanding of what A&BI capabilities healthcare organizations are utilizing to enhance value. Based on extensive search of the literature and a follow-up case study of a large regional hospital, it was found that the existing healthcare value chain (HCVC) framework is outdated and no longer effective. We therefore revised and updated the existing framework to meet the current needs of modern healthcare practices. Moreover, A&BI applications currently being deployed in healthcare organizations were identified and mapped onto the revised framework. The study contributes by illustrating how healthcare organizations currently utilize or should be using A&BI capabilities to enable them close the quality gaps.

Keywords

Analytics, business intelligence, healthcare, capabilities, value chain

INTRODUCTION

Healthcare organizations remain data-rich but information-poor due to their inability to keep up with the rapid growth of their data by leveraging state-of-the-art analytics and business intelligent (A&BI) tools and techniques. Despite the rapid growth in their data, healthcare organizations still face myriads of challenges in their deployment and use of A&BI systems, techniques and technologies (Sharma, Mithas and Kankanhalli, 2014). Among their current challenges include insufficient resources, inadequate technological infrastructure, and lack of or limited understanding of the application of A&BI to business, quality issues, and performance goals across organizations and stakeholders.

Based on extant literature, healthcare organizational value creation and delivery has been studied under only one framework (see Figure 2) originally developed by Burns, DeGraaff, Danzon, Kimberly, Kissick and Pauly (2002). This framework focuses mostly on hospital operations and other healthcare activities that result in value creation and delivery within the hospital environment. However, healthcare organizations are currently shifting their focus onto IT-enabled systems and processes to boost care delivery (Byrne, Mercincavage, Pan, Vincent, Johnston and Middleton, 2010; Perez-Cuevas, Doubova, Suarez-Ortega, Law, Pande, Escobedo and Wagner, 2012) and value creation (Bardhan and Thouin 2013; Lichtner, Venters, Hibberd, Cornford and Barber 2013). Such value creation initiatives are not only occurring within hospital premises but also by remotely reaching out to people within their communities. As several healthcare providers were presented with Burns et al. (2002) framework and asked to share their opinion on how this framework is currently being applied to boost value creation, it became evident that the current framework is outdated, insufficient, and ineffective in providing the current needs of healthcare organizations.

Owing to the potential paradigm shift in care delivery under the current care regulations, it becomes imperative that the Burns et al. (2002) HCVC framework, which is almost two decades old, is thoroughly reexamined for its relevance and reliability. Motivated by the lack of recent studies that explains this framework, and how A&BI capabilities can be applied within the context of the framework to derive value in healthcare organizations, this study is being conducted to investigate the influence of A&BI systems and applications on the HCVC framework activities. We achieve this aim by addressing the following key research questions: *i) which IT-enabled analytics and business intelligence (A&BI) tools and techniques are currently being implemented to enhance value creation and delivery within the different domains of healthcare organizations value chain network? And ii) how are these key A&BI systems and applications being leveraged or utilized in the various domains of the value chain in healthcare organizations?*

To address these research questions, a case study (Walsham, 2006) approach was used to explore and describe the case of a large healthcare organization with five affiliate care-providing subsidiary organizations. Specifically, we

draw on interpretive case methodology to answer our research questions by studying and interpreting a large healthcare organization's perspective on the current value and relevance of the existing HCVC framework.

This study contributes to existing literature by being the first to review and redevelop an updated HCVC framework that is mainly driven by A&BI techniques, and therefore expected to draw several research interests from various researchers. For example, the revised framework can be used to conduct several empirical studies to address how healthcare organizations are currently utilizing IT-enabled A&BI applications to create and deliver value for both the consumer and provider. Moreover, the revised HCVC framework contributes to healthcare practice by illustrating how health IT-based A&BI is currently transforming and reforming the current practices within the general healthcare ecosystem. This will help healthcare organizations to consider re-strategizing and revising their existing approach to value creation and delivery to meet current practices.

THEORETICAL BACKGROUND

The Healthcare Value Chain (HCVC) Framework

This study is grounded in the concepts of Burns et al. (2002) healthcare value chain framework which was basically adapted from Michael Porter's (1985) Value Chain Framework originally developed to investigate how healthcare organizations are creating value through their primary and secondary activities. In the healthcare context, however, a modified version of Porter's (1985) original value chain has proved useful in understanding how various activities are tailored toward quality of care delivery fit together (Sastry, 2014).

Porter (2002) introduced the concept of value chain in his book with an idea that every organization has two distinct sets of activities to create value (Figure 1). One activity set is the primary activities that is involved in creating physical product or service, marketing and delivery of the product or service, and support and after-sale service for that product or service. Another set is the supporting activities of the organization. The supporting activities are composed of internal activities of the organization which provides inputs and infrastructure to support the primary activities. Porter (1985) describes five primary activities as generic supply chain activities of organizations' value chain: Inbound logistics, operations, outbound logistics, marketing & sales, and after- sales service. The four supporting activities of organizations' value chain are: procurement, technology development, human resource management and firm infrastructure.

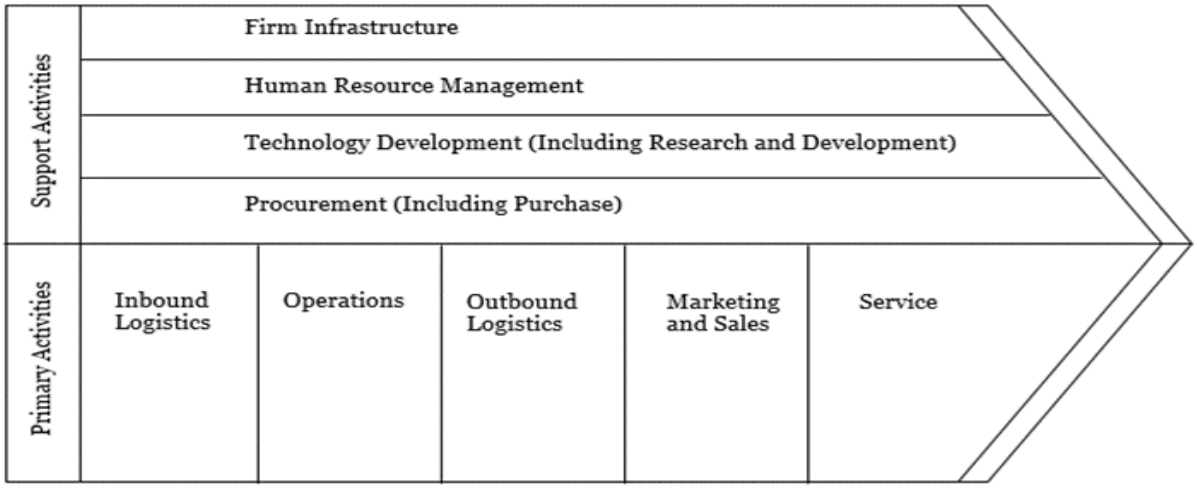

Figure 1. Porter's (1985) Value Chain Framework

The healthcare value chain framework was introduced in the healthcare industry during the early 2000s as a result of several major developments such as vertical integration, horizontal integration, managed care pressures, changes

in federal reimbursement policies, the evolution of e-commerce, and the passage of the Health Insurance Portability and Accountability Act (HIPAA) in 1996.

Burns et al. (2002) developed a more conventional value chain framework that is specifically tailored towards healthcare organizational needs (Figure 2). This framework was developed based on Porter's (1985) original organizational value chain framework (VCF). Our study draws on the concepts of Burns et al. (2002) value chain framework which was proposed to basically explain how healthcare organizations are creating value through their primary and secondary activities.

In the context of healthcare, however, the value chain framework is redefined reversely in such a way that the support activities, which comprise of hospital support services; hospital diagnostic and therapeutic services; information services; and hospital administration, collectively form the foundation activities. Primary activities comprise of a set of front-end core activities which include admission, care, discharge, marketing and sales. We elaborate on each of the segments within the primary and support activities of the HCVC framework in the following section. Figure 2 below is the existing HCVC framework originally proposed by Burns et al. (2009).

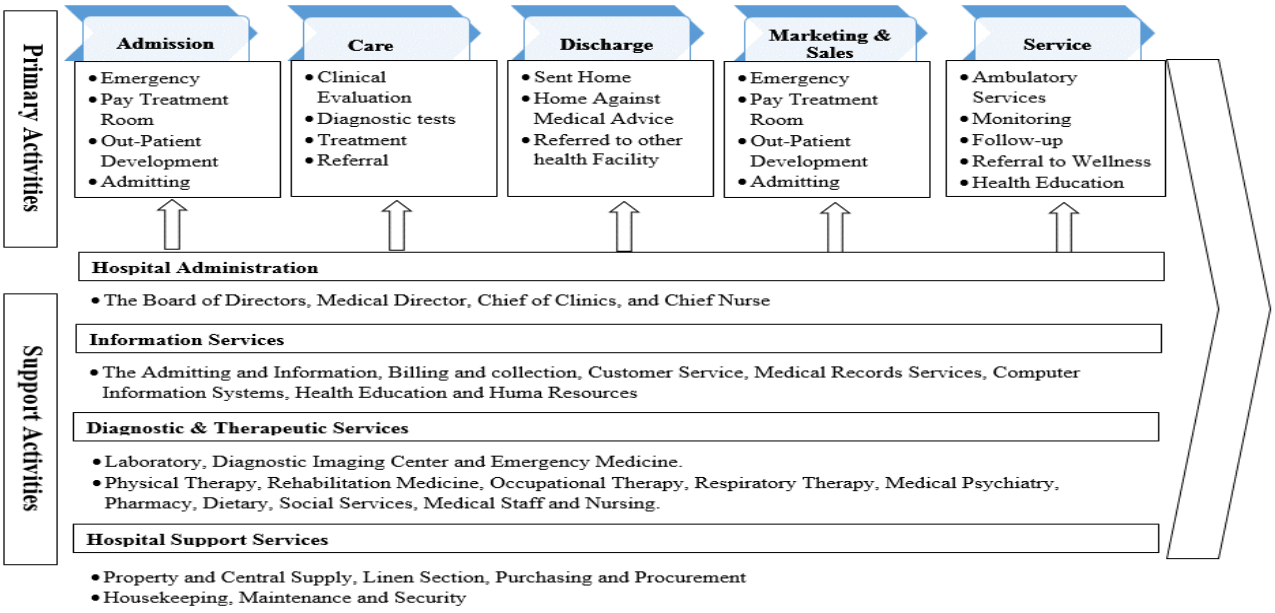

Figure 2. Healthcare Value Chain Framework (Adapted from Burns et al. 2002)

Primary Activities

The admissions unit within the primary activities is regarded as the main gateway or the first point where patients make their first contacts with the healthcare organization. Among the different units where such first contact can be made include the emergency department and the front desk unit. Patients who report with various kinds of serious illness are eventually admitted into the emergency room for the necessary treatments to be administered on them. In addition, other activities that are performed in the admission unit include payment for treatment received, outpatient development activities, discharges, etc.

During the period whiles patients are on admission, they begin to receive series of care treatments that includes activities such as clinical evaluation, running of diagnostic tests, administering of various treatments and referrals. During this time, healthcare providers utilize the acquired knowledge and expertise in medicine to diagnose

patients' illness, treat such illness by providing them with the best of care to speed up their recuperation process, and discuss referral options if needed.

As patients gets better through the treatment received during the care process, the healthcare providers then prepare for discharge so they can go back to their various homes. During this discharge process, patients are then either sent directly home with no follow-up discussions if fully recovered from their illness, or they are sent home with follow-up checkup/discussions if they feel the need for such services. In situations where patients will need more monitoring and further evaluations, they may then be discharged to other healthcare or homecare facilities.

Fully recovered patients may often receive marketing and sales or advertisement communications from the healthcare organization they received treatment and care. Among some of such communication include options patients can choose to pay their copayments after their insurance payments, other out-patient development information such as advice on regular exercise activities to keep patients stay healthy, etc.

Finally, in the primary activities is the additional follow-up services patients usually receive after they have been discharged. Among some of these services include remote monitoring of patients' condition that comes in the form of exchange of communications through technologies such as patient portal, emails, etc.; ambulatory services to be received if the need arise for patients to go back to the hospital; referral to wellness facilities, social clubs or activities as well as other beneficial health education resources that may be available at less or no cost to patients.

Support Activities

Support activities are generally all the non-front-end activities that are provided to primarily support the mainstream running and operation of the healthcare organization. Hospital administrative operations is regarded as one of such activities within the support activities category. The administrative unit represents the healthcare organizations top leadership and decision-making bodies that oversee the hiring of well-qualified staffs, enactment and implementation of organizational policies and regulations, and making strategic decisions that drives the organization. Setting of organizational target and reward systems are other core functions of the administrative unit, which is often comprised of the Board of Directors, Chief Medical Director, Chief of Clinics, and Chief Nurse.

Next to the hospital administrative unit are the leaders of other line-of-business within the healthcare organization such as the Information Services/Technology (IT) unit, Financial and Accounting unit, Operations unit, Marketing unit and Human Resources unit. The IT unit, for example, provides all the needed technology support and services within the healthcare organization. This comprise of both hardware and software needs that range from installing desktop or laptop computers, securing and protecting the organization's information, creating and developing in-house programs and systems to collect, store, analyze and share medical record data or information, etc.

In addition, the diagnostic and therapeutic services unit also provides several different needed support services such as lab work, diagnostic imaging (x-ray) services, emergency medicine services, physical therapy services, and rehabilitation medicine services. The unit is also in charge of providing occupational therapy services, respiratory therapy services, medical psychiatry services, pharmacy, dietary and social services among other things.

Last in line is the hospital support services unit that provides various essential support services such as housekeeping, maintenance and security, property and central supply, purchasing and supply services, etc. This unit provides crucial services to the front-line working staff by making sure that the working environment is always safe, healthy and devoid of any potential transmission of diseases.

Healthcare organizations depend on this configuration of value-chain mapping to identify how to improve quality (or lower costs) of care by delivering or connecting patients to the services in order to fully benefit from the entire chain of activities needed for better care [39]. This healthcare value chain (HCVC) framework was used as the main theoretical lens in conducting this study. In other words, Burns et al. (2002) version of HCVC framework was used

to identify which analytics techniques and technologies healthcare organizations are currently deploying and how these are contributing towards improving quality of care and overall performance or outcome.

RESEARCH METHODOLOGY

Case Study Design and Case Selection

To accomplish our research objectives, we used a theory-driven exploratory case study approach which we deem appropriate for the following reasons. First, this study explores *which* and *how* IT-driven A&BI are being leveraged to facilitate value creation in healthcare organizations. Prior studies (Yin, 2009) have shown that exploratory case is preferred when addressing such "how" questions because of its holistic and descriptive nature. The second reason is that value creation and delivery between healthcare providers and consumers occurs in a complex and dynamic processes. Exploratory case study has been shown in the literature to help explore such complex and contextual phenomena, deduce key ideas from complicated process, and determine the potential of those ideas in the given context (Stake, 1994). In addition, an exploratory case study approach has widely been acknowledged as a means for providing rich insight into, and explanation for, new and emerging phenomenon like the adoption and use of current and emerging IT-enabled A&BI techniques by providing descriptive evidence (Benbasat, Goldstein, & Mead, 1987; Lee, 1989; Miles and Huberman 1994, Yin, 2009). Third, few studies have explored the role of IT-driven A&BI capability in value creation in healthcare context as this research field is still nascent and evolving. Therefore, a theory-driven exploratory case study is preferred in order to identify new theoretical constructs, build a new theoretical framework, and advance previous research in this context (Klein aand Myers, 1999; Glaser and Strauss, 1967).

A key aspect in case study design is deciding the number of cases to include in a research (Yin, 2009). Unlike a single case counterpart, multiple cases follow replication logic which requires each case be selected carefully so that it presents either similar results (a literal replication) or contrasting results for expectation reasons (a theoretical replication) (Klein and Myers, 1999). Following literal replication logic, this study was designed to establish a general theoretical framework of A&BI. We chose an integrated network of five healthcare organizations from the healthcare industry which autonomously operates separately on their own. This design makes it relatively easy to compare our findings, to increase reliability, and to decrease sensitivity (Yin, 2009; Benbasat et al., 1987). We selected our sample using three criteria. First, the selected case firms have independently started implementing and leveraging some form of A&BI capabilities to create and deliver value. Second, the selected case firms are good representatives as they exhibit characteristics of frontrunners in their market segments. Third, the case study firms are of different sizes although they belong to the same industry. Table 1 shows the profiles of the five selected case firms.

Firm	Industry	Area Specialization	No. of Employees	No. of Beds
I	Healthcare	Heart & vascular	320	238
II	Healthcare	Endoscopy, cancer & sleep disorders	330	110
III	Healthcare	Pediatric & adult inpatient crisis management	285	80
IV	Healthcare	Oncology, bariatric care, urology, and orthopedic medicals	415	178
V	Healthcare	General primary care and Teaching hospital	10,650	517

Table 1. Case Firm Profile

Case Firm Description

We identified a large healthcare organization with five affiliate care-providing organizations to investigate organizational personal experience with A&BI use and value creation through the use of A&BI. This healthcare organization is deemed appropriate to be used as the case subject because not only is it growing and expanding its IT-enabled A&BI activities, but also because management expressed interest in investing how to significantly elevate their current A&BI capabilities to industry standard. In addition, management wanted to know how their current state of IT-enabled A&BI capabilities and applications compare with other leading healthcare organizations in providing value added patient-centric care. In this regard, top management of the organization were very supportive and cooperated in facilitating data collection and other necessary logistics needed to ensure that the research is successfully carried out.

The Healthcare Organization (HCO) is one of the largest care providing organizations (ranks among the top 2% best "High Performing" care systems in US) located in the South-Eastern part of the U.S. This HCO is a non-for-profit healthcare network serving people living in five major counties with the primary objective of providing excellent and quality care for its patients. With its high commitment to excellence, which is shared by more than 11,000 employees, 1,300 physicians, and 1,200 volunteers, the HCO is regarded as one of the region's largest and most comprehensive healthcare networks comprising of six major hospitals or medical centers. The hospital within this larger healthcare system saw about 25,395 discharges and 106,662 emergency department visits according to the 2020 Fiscal Year record. In addition to its size, this HCO also boasts of rising revenue as more outpatient services are being delivered and its operating surplus is back on the rise too. In total, the HCO reported an operating surplus of $33.4 million on revenue $1.4 billion for the 2020 Fiscal Year.

While the unit of analysis for this research is healthcare organization, data was collected from a total of 30 IT employees and other top-level managers (see Table 1). Hence, the unit of analysis is based on aggregate perspectives of employees' and managers' experience in the use of diverse IT and A&BI systems in their organization. Participants interviewed come from varying education and qualification background. We asked unique questions related to the role of study participants within the organization. For example, participants were asked to provide exemplar use cases of how they apply IT-enabled A&B systems, tools and techniques; the challenges they faced; and benefits they have gained.

Different tasks or use cases successfully executed through IT were explained by the 30 different IT employees and managers interviewed and their interpretations were recorded on audio recording machine and paper for further analysis. In addition to the interview, company documents and other secondary sources such as articles, news publications, company's annual reports, etc. were also examined. This triangulation across multiple IT employees and managers, as well as other secondary sources, provide rich and manifold perspectives of data used to effectively address the research questions, in addition to validating the underlying concept (Corbin and Strauss, 2008, Orlikowski, 1993).

Data Collection & Analysis

We used open-ended semi-structured interview techniques with probes (Rossi, Wright and Anderson, 1983) to collect primary data over ten months' period from a total of 30 IT staff and managers in the primary healthcare organization and its affiliates. Interviewees come from diverse educational background with rich IT-related work experience (see Table 1). The idea of using multiple informants from variety of functional backgrounds and levels originated from Phillips (Phillips, 1981), who strongly argued that multiple informants are more reliable sources of data collection than just a single informant.

Job titles or position held by participants include Chief Medical Officer (*R1*), Chief Medical Information Officer (*R2*), Chief Data and Analytics Officer (*R3*), Executive Director of Healthcare Analytics (*R4*), Director of Clinical

Business Intelligence (*R5*), etc. Participants were randomly assigned pseudonyms, *R1,…., R30*, (see Table 1) in order to protect their identity based on prior data masking agreement.

Interview participants were identified through peer and management nomination. Abdolmohammadi and Shanteau (1992) have shown that professionals in a field are competent in identifying a consistent set of attributes they associate with experts. Therefore, nomination rather than factors such as job titles and education level was used in identifying respondents.

An interview protocol (see Appendix A) was used as a guide to facilitate the data collection process. This protocol was loosely developed from the available general frameworks of expertise but was designed to elicit and probe concepts mentioned by interviewees. Respondents were asked to provide exemplar use cases where a particular IT or A&BI used has caused changes in the way they execute certain tasks.

No.	**Informant**	**Job Title/Position**	**Education Level**	**Years of IT-related Work Experience**
1	*R1*	Chief Medical Officer	Ph.D., MD	8
2	*R2*	Chief Medical Information Officer (CMIO)	MD	15
3	*R3*	Chief Data and Analytics Officer	MBA	25
4	*R4*	Executive Director of Healthcare Analytics	MSc in Nursing & Certificate in Business	16
5	*R5*	Director of Clinical Business Intelligence	BSc. in IT	24
6	*R6*	Director of Meaningful Use	MBA, RHIA	40
7	*R7*	Health Information Analyst	BSc. in IT	12
8	*R8*	Instructional Designer (Epic Operations)	MSc. in IT	12
9	*R9*	Health Information Mgt./Identity Instructional Designer	MSc. Health Administration	10
10	*R10*	Manager of BI Systems	MSc. in IT	10
11	*R11*	Systems Analyst III	MBA	28
12	*R12*	Business Intelligence (BI) Application Analyst	BSc. Engineering	12
13	*R13*	BI Application Systems Developer and Analyst	BSc. Computer Science	7
14	*R14*	BI Report Developer	Ph.D. in IT	5

15	*R15*	BI Developer	MSc. in IT	12
16	*R16*	BI Report Developer	BSc. Business Administration	5
17	*R17*	Reporting Analyst	BSc. Computer Science	15
18	*R18*	Data Architect	Master's in IT	14
19	*R19*	Systems Analyst II	BSc. Computer Science	8
20	*R20*	Database Analyst Logical	BSc.	15
21	*R21*	Technical Analyst	BSc. Computer Information Systems	15
22	*R22*	BI Report Developer	MSc. Health Administration, Registered Nurse (RN)	12
23	*R23*	ETL Developer	BSc. Computer Science	12
24	*R24*	Director of Epic Operations & Training	MSc. in IT	10
25	*R25*	Manager, Quality Performance and Clinical Informatics	Master of Science in Nursing, (MSN)	14
26	*R26*	Chief Administrative Officer	MBA	20
27	*R27*	Reporting Analyst, Clinical Business Intelligence	MSc in IT	10
28	*R28*	Director, Physicians/Clinical Services	MD	20
29	*R29*	Application Analyst, Clinical Informatics	MSc in IT	12
30	*R30*	Application Analyst	BSC in Business Admin.	14

Table 2. Interviewee Background Information

Based on responses to the questions, probing questions were further asked to elicit specific insight. Each interview lasted between 40-60 minutes. Once each interview session was completed, field notes were typed, and audio recordings transcribed into word documents ranging between 6-12 pages using a software called "Transcribe". Table 2 below provides descriptive statistics of respondents in this study.

	Number of people interviewed = 30	
	Mean	**Standard Deviation**
Experience in doing or managing IT related work (number of years)	14.63	7.43
Age (number of years)	45.90	11.17
Education		
Undergraduate degree (%)	36.67	----
Graduate degree (%)	50.00	----
Post graduate degree (%)	13.33	----

Table 3. Descriptive Statistics of Respondents

Transcriptions were independently carried out by researchers and associates, compared and contrasted, and eventually consolidated into one final document. Each final consolidated transcription was then sent back to the respective informant for content validation. The majority of the informants confirmed that the transcriptions were true reflection of exactly what they said and that, there were no errors or mistakes in the transcript document they have reviewed. However, about 2-3 informants identified a few minor errors in the transcripts and they played an instrumental role by providing guidance and directions to help correct the anomalies. After the transcription, the process of unitizing and categorizing was carried out in a qualitative data analysis software (Atlas.ti and R Qualitative Data Analysis [RQDA]) program which helped make more sense of the data. Unitizing is the coding operation in which information is isolated from the text (Parveen, Jaafar and Ainin 2015; Glaser and Strauss, 1967). We used axial coding method to help tease out emerging themes for various sections that were identified from the transcripts. The words, phrases, etc. were then coded based on common themes that have been agreed on prior to the analysis (Stake, 1994).

We used four methodological data-analysis steps interwoven into the cycles of the hermeneutic circle as adapted from van Kaam (1966) and Moustakas (1994); *epoché*, *phenomenological reduction*, *imaginative variation*, and *synthesis*. In the first step, *epoché*, we identified and set aside any personal biases and pre-judgment for each hermeneutic cycle. For the second step, *phenomenological reduction*, we prepared a textual description of each interview. We used the resulting narratives, which comprised of about 5000 statements, to recognize and identify the discussed issues, the participants' viewpoints, and the meaning of individually experienced phenomenon (Moustakas, 1994).

We analyzed the narrative statements and coded the statements to represent and classify their content. Using the open-coding process (Glaser and Strauss, 1967) we identified the aspects of A&BI use in the organizations that had some importance to study participants. We subsequently reviewed the preliminary codes and combined those with similar meaning in a context relevant to this study. We consequently refined the coding system to comprise only 25 codes, which were applied to all narrative statements to identify those aspects of A&BI that, from the perspective of the study participants, had some relevance to and significance for organizational value creation and delivery.

In the third phase, *imaginative variation*, we determined the structure of the phenomena and their meaning. In this process, we explored the previously identified themes by varying participants' perspectives and adopting different frames of reference to look for overlaps, confirmation, complementarity, and conflict in the views that participants

held. Lastly, in the final step of the hermeneutic phenomenological process, *synthesis*, we identified the essence of study participants' shared experience. We further compared and contrasted such shared views with the extant literature on A&BI applications in healthcare organizations and performance improvement. In the following section, we present the general findings from this study with extensive discussion about the study's main outcome.

RESEARCH FINDINGS AND DISCUSSIONS

To expatiate on the connection and relationship between IT-enabled A&BI capabilities and healthcare organization value chain, we describe a comprehensive process using the case evidence we collected and analyzed via the process described above.

Evidence for the Need of a Revised/Updated HCVC Framework

When interviewees were presented with the healthcare value chain (HCVC) framework and asked to share their opinion about the framework's relevance and applicability with regards to the current healthcare organizations' general practices, majority of respondents remarked that the framework is outdated and therefore needed major revision. Thus, about 27/30 (representing 90%) of participants strongly recommended a revision to the current HCVC framework because the current framework was regarded outdated and as such, it does not sufficiently represent current healthcare practices.

After thorough analyses of interviewees' experience with the current healthcare administration and practices, it became apparent that the Burns et al. (2002) HCVC framework indeed needed major revision. For example, the Chief Medical Officer, the Chief Medical Informatics Officer, the Executive Director of Healthcare Analytics, the Director of Meaningful Use, etc. all came to the same conclusion that a newer version of the HCVC framework that reflects current healthcare practices would be more useful to healthcare organizations. They went on further to describe the current system of the healthcare value chain as being more focused on the *population health management (PHM)*.

Below are selected excerpts from the interview responses that suggest the need to revise the HCVC framework:

> *"All healthcare organizations are trying to do is more preventive and more relationship building with the patient, I don't see where that is covered in your primary activities of the HCVC framework. (R15, BI Developer)*
> *It's a bit confusing to me.. everything under the supporting activities.... like how does one know what's supporting the primary activities."* (R13, BI Systems Developer & Analyst)

Respondent (R13) went on to say….,

> "*Personally, I think the framework needs to be updated. This is reactive from back in the day, we are moving more to becoming proactive, identifying risk factors for patients coming in to the ER for whatever and they came in multiple times for these three different reasons. This is leading up to the bigger issue that they are going to be admitted for possible death where it starts at re-admission and move forward. We are reaching out to them before admission. We are coming in just to see their Primary Care Provider, we are doing a lot more than what we are used to, and also, with how we get paid now - we get paid fee-for-service now. In the past, we wanted you to come in and get sick and we'll pay but now we are getting paid to keep you out of the hospital. So, I would say the HCVC framework you have is outdated.*" (R13, BI Systems Developer & Analyst)

Another respondent (R19) also echoed similar remark as follows:

> "*As far as primary activities from what I'm seeing on this framework are concerned, yeah, I would say discharge and admissions probably should be wrapped into one kind of area. I mean, to me*

> *discharge and admissions are kind of little fuzzy and I can't read the care part that goes underneath the same scenario. The admissions and that part of the whole care atmosphere that we currently have here at my organization is that being discharged and sent home for observations is where we are currently heading towards. So, to me, those three areas (admissions, care, discharge) must be merged because they are kind of grey areas and the data kind of merges a lot in these areas.*" (R19, Systems Analyst II)

Based on these revelations, it becomes apparently necessary that the HCVC framework is indeed revised in a way that is geared towards the current needs of care delivery. It was learned from the interviews that healthcare organizations are now shifting towards new approach to care management by forming partnership with all stakeholders to ensure that the masses of the population stay healthy and minimize the risk of being severely sick as emphasized in the following excerpt:

> "*We have moved away from this kind of hospital admission in the traditional hospital care type thing into a process that basically aims at how can we keep people healthy and out of the hospital in the most cost effective way.*" (R3, Chief Data & Analytics Officer)

In view of this, the call for a revised version of the framework that currently captures healthcare organizational practices and needs is appropriate and timely. As a result, we propose a revised HCVC framework (see Figure. 3) using inputs from interviewees' responses as expressed in the following excerpts:

> "*I think I would change the order. I really think these days it's like in the form of a circle... it's not like the layout as you present. It goes back and forth like a wheel. You start from service, we want people to be away, and providing care to them at their home, it costs the hospitals when there are more admissions, kind of like.... the hospital is trying to avoid penalty and all that. So they try to be more focused on the low-risk people within the community. They want to keep everybody healthy*." (R22, BI Report Developer)

The Revised Healthcare Value Chain Framework

The revised HCVC framework is presented in Figure 3. This framework describes a process that comprise of two major distinct categories: primary activities and support activities, with the primary activities having two subcategories: clinical care giving services and non-clinical care giving services. Furthermore, the nature of the framework and the relationships between the concepts and categories suggest that the current healthcare process is in a circular form, with population or consumer wellness being the core objective around which is a feedback loop among different categories within the framework. We present a schematic diagram of the revised HCVC framework in Figure 3 below followed by explanation of the different layers, categories and concepts.

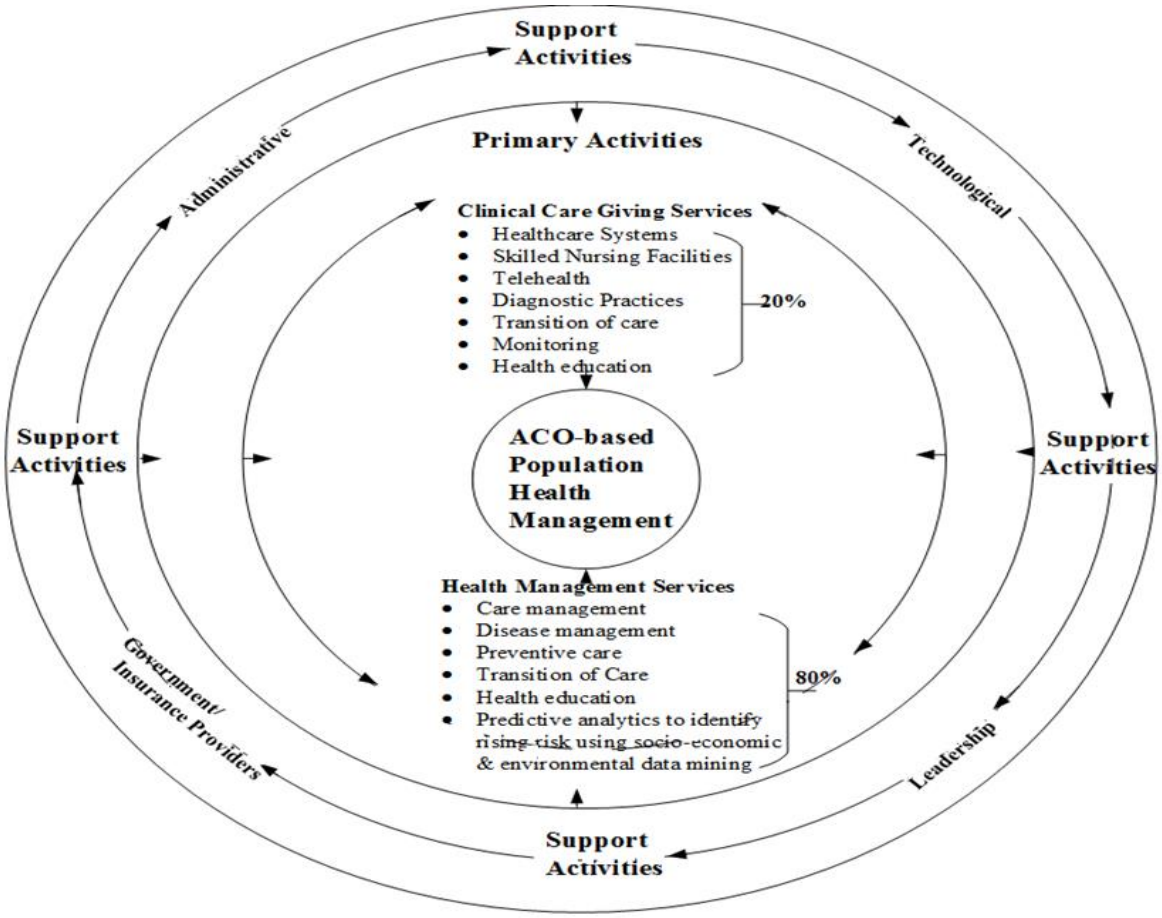

Figure 3. Revised Healthcare Value Chain Framework Centered Around Population Health

ACO-based Population Health Management Layer

The Accountable Care Organization (ACO)-based population health management layer is the core layer in the revised HCVC framework as it captures the core objective of current care delivery. The revised HCVC framework above shows how healthcare value creation and delivery process has significantly been transformed and still keeps reforming into population health-centric. In other words, the focus of current healthcare providing organizations is to keep the general population healthy remotely by using IT-enabled A&BI to monitor consumer behavior as well as help inform decisions and choices pertaining to their health. In the center (core) of the revised framework above is the main objective of the current healthcare industry which is basically to ensure that majority of the population or consumers stay healthy in their communities. This is amplified by the following excerpt from the interview:

> "*We have moved away from this kind of hospital admission in the traditional hospital care type thing into a process that basically aims at how can we keep people healthy and out of the hospital in the most cost effective way.*" (R3, Chief Data & Analytics Officer).

Primary Activities Layer

Next to the core (nucleus) is the primary activities that healthcare organizations provide. The primary activities, according to interview responses, comprise of two main tasks or services: 1) clinical care giving, and 2) health management services. Clinical activities are the conventional care-delivery activities that healthcare organizations

provide to their patients within the hospital or care-providing environment. This includes services such as admissions into the hospital facilities, diagnoses of diseases, treatment, transition of care, skilled nursing care facilities etc. Healthcare providers are currently aiming to minimize growing number of the population that receive care and other services within the hospital facilities to not more than 20% of their entire patient population. This is amplified in the following except from one of the respondents (R6).

> "*We (i.e. our organization) try as much as possible to meet current industry standard of care delivery and value creation. As such, we try to engage majority of the people in the communities by remotely reaching out to them through social media, blocs, emails, etc. with wellness-keeping advice and other interventions to help them stay healthy so they don't have to come to the hospital because they are sick. This way, we are able to offer better treatment services up to about 20% of people who are seriously sick and need our utmost attention.*" (R6, Director of Meaningful Use)

The other service provided within the primary activities is the health management services (HMS) which healthcare organizations are now trying to achieve through high investment in IT. HMS involves managing the health of the remaining 80% Accountable Care Organization (ACO) enrollees, who belong to the low-risk category of the population, through collaborative effort of clinicians, IT, care coordinators, and business analysts to proactively engage and work with their patients in order to help minimize the risk of them falling into the high-risk patient category. HMS-based activities include medical care, public health interventions, genetics, and individual behavior, along with components of the social (i.e. income, education, employment, and culture) and physical (e.g. urban design, clean air, and water) environment.

With HMS, healthcare organizations are also attempting to encourage the healthy population to frequently indulge in exercises, constantly reminding them to be conscious about their living environment and encourage the pursuit of higher education in order to be able to get high earning jobs that will help provide for their basic needs.

Support Activities Layer

The support activities layer is the outermost layer in the proposed healthcare value chain framework which healthcare providers also deem very important in creating and delivering value to consumers. As can be seen in the revised framework, the arrows pointing from each of the layers towards the inner core (nucleus) of the framework symbolizes either direct or indirect influences of each layer on value creation and delivery process towards the inner population (nucleus). Thus, through extensive use of IT, healthcare organizations are targeting to remotely deliver valuable care and other health services to the majority of the population (80%) by partnering with them and other stakeholders (government agencies, insurance providers, etc.) to help them make informed decisions about their health. For example, the Chief Data & Analytics Officer confirm this remote outreach strategy HCOs are now adopting to improve health conditions of the masses as captured in the following excerpt:

> "*… and I think we talked about it, what you know if our goal is healthy community then we support people in their daily lives for the eighty to ninety percent of the time that they are not engaged with us right and how do we do that and of course how do we do all these other things like you mentioned for the 10-20% of the time when you are engaged*."
> (R24, Director of Epic Operations & Training)

Other support activities that also impact value creation and delivery include leadership and administrative support/commitment, government and insurance providers' policies and agreements, etc. Respondent (R3) alluded to specific example of the support activities as captured in the following excerpt:

> "*The only thing I was thinking about – and you sort of hit on it – is apparently you have the discussion about the transformation towards let's keep you healthy and there is a lot that have to transform in the healthcare system to support that particularly reimbursement because there is no*

incentive for Physicians to do that other than altruistic incentives right now." (R3, Chief Data & Analytics Officer)

In summary, unlike the old HCVC framework (see Figure 2) originally proposed by Burns et al. (2002), the current proposed HCVC framework differs in many ways. One major change that majority of the interview respondents pointed out is about the cyclical nature with feedback loop process of the current healthcare practice. Based on these revelations, it becomes important that the current framework is represented in a cyclical nature to emphasize the fact that peoples' health is influenced by so many factors around them. Table 4 below is a summary of specific activities that are carried out in each of the various domains of the revised HCVC framework. Information in each of the various regions are further elaborated in the following section.

Primary Activities	**Clinical Care Giving Services**	Examples include: Healthcare systems, skilled nursing facilities, telehealth, diagnostic practices, transition of care, monitoring systems, and health education			
	Health Management Services	Examples include: Care management, disease management, preventive care, transitions of care, health education, predictive analytics identify rising risk using socio-economic and environmental data mining techniques			
Support Activities		Technological support • IT infrastructure • Software • IT enabled process/techniques	Administrative Support • Strategic planning • Effective management and use of resources	Leadership Support • Leadership style • Strategic alignment of clinical and business activities	Government and Insurance Providers • Policies • Standards • Regulations

Table 4: Summary of Primary and Support Activities Layer

Clinical Care-Giving Indicators

Due to the complexity of the current healthcare system, and the myriad factors that impact quality and performance, it is impossible for a single metric or indicator to reflect accurate changes to the systems. For example, efficiently functioning HCOs must measure many aspects of their systems and procedures including healthcare systems activities, skilled nursing facilities, telehealth, diagnostic practices, transition of care, monitoring systems, health education, etc. Each of these components are further explained in Table 5 below.

Clinical Care-Giving Indicators	Explanation
Healthcare systems (HCS)	This is the organization of people, institutions, and resources that deliver healthcare services to meet the health needs of target population.
Skilled nursing facilities (SNFs)	SNFs are nursing facilities that are equipped with highly skilled nurses who provide quality treatment and services. Patients in

	SNFs are generally shorter stay patients who are receiving continued acute medical care and rehabilitative services.
Telehealth service (ThS)	ThS is the use of remote communication or monitoring mechanisms (e.g. telephones) for care coordination such as timely communication of test results, timely exchange of clinical information to patients.
Diagnostic practices (DP)	DP is the ability of HCOs to provide the best possible care at the right time by using the right techniques and procedures to detect and treat diseases to the right patients in the most efficient and safe manner possible.
Transition of care (ToC)	ToC is the situation in which a patient is transitioned or referred from one care facility to another setting of care or healthcare provider for better treatment and care.
Monitoring	Monitoring is the time period of care giving during which healthcare providers assess if allowing for extended time requirements may enhance the value associated with generating more efficient outcomes, or conversely, the extended time, may reveal that more time has little or no value added for activities when associated with desired outcomes.
Health education (HE)	HE is any combination of learning experiences designed to health individuals and communities to improve their health by increasing their knowledge or influencing their attitudes.

Table 5: Clinical Care-Giving indicators and their explanations

Support Activities

These are activities such as technological support, administrative support, leadership support, and other stakeholder support, that help drive high quality of care delivery within HCOs. Each of these activities are explained in details in Table 6 below.

While each of these domains is equally important and warrants further research investigation to help HCOs improve the quality of service they provide, this study only focuses on the *technological support activity* domain as it is one of the key interests of HCOs. Thus, we highlight the various IT applications in relation to (A&BI) technologies, techniques and processes that are currently being deployed within each of the various domains of the HCVC framework.

Support Activity	**Explanation**
Technology support	This comprise of IT infrastructure (e.g. hardware, software) and IT-enabled process and techniques that HCOs heavily rely on to provide better care quality. Due to the new ACO Act regulations, HCOs are now increasing their investment in technological solutions to better manage business operations and treat patients.
Administrative/Leadership support	This encompasses effective administrative and leadership strategic planning, effective management and strategic use of resources, and strategic alignment of clinical and business activities that HCOs implement in order to provide quality of care and services.
Governmental and other stakeholder support	Government and other stakeholders such as insurance providers also provide support to HCOs in a form of incentives (such as the HITECH Act and Meaningful Use requirements) with the aim of motivating them to provide better quality of care and services.

Table 6: Support Activities with their Respective Detail Explanation

Validation of the HCVC Framework

Application of IT-enabled A&BI Tools and Techniques in the Revised HCVC Framework

To answer the research questions guiding this study, the revised HCVC framework was sent back to all the 30 interviewees of the same case organization. The reason is to have them validate the revised HCVC framework, and also provide their knowledge or perspectives about the use of various IT-enabled A&BI systems, techniques and processes that are currently being applied in each domain of the revised HCVC framework. About 95% of respondents consented to the revised HCVC framework as being a true reflection of how value creation and delivery to patients and to their organization is being leveraged per the current care-giving standards.

Based on the follow-up case study data complimented with in-depth content analysis of the extant literature, we found that healthcare organizations are currently expanding their investments in new and emerging IT-enabled A&BI systems, processes and techniques. Respondents provided broad varieties of IT-enabled A&BI systems and tools currently being implemented in healthcare organizations as revealed in the following excerpts:

> "*Analytics and business intelligence is definitely growing in our organization and currently there are a few of the technologies we look into – some of them are being implemented and some of them are being planned. For data screening, we use the traditional systems such as Excel, SAS, and Minitab. However, due to the rapid growth in volumes of data that we have, we have decided to go into EPIC integrated systems where we are able to query massive data and extract reports. Moreover, we are also currently exploring the possibilities of implementing big data systems such as Hadoop Ecosystems.*" (R1, Chief Medical Officer)

> "*We are currently growing and as such, we have been exploring all the open sources that is available in the market which can be leveraged to perform better analytics. In that regards we look into analytics and visualization tools like QlickView. We want to be able to use it for certain types of analytics but we found Hadoop as being a very strong tool.*" (R12, BI Application Analyst)

> "*So we have a big strategy which we call a data-driven strategy. Our strategy is to become data-driven Healthcare Organization. The foundation of that which is the Enterprise data warehouse (EDW) will be used to bring together and integrate data from some of our major systems obviously EPIC which is the major EMR system. So we use right now mainly two technologies - we use the Microsoft BI stack that here we refer to it as Power BI. We use that and then we use QlikTech or QlikView to render visualizations of dashboards and reports from the data warehouse. We will eventually bring in Tableau which will be another one and then part of our bold vision with the analytics troop is to have data scientist and advanced data analytics for predictability and things like that so we will probably bring in Python and R and few other tools so that we can do some of that modeling.*" (R5, Director of Clinical BI)

In addition to these A&BI systems, tools and techniques revealed from the case study, we also identified additional A&BI systems, tools and techniques in the literature that either confirms or compliments the findings from the case study. We then mapped these A&BI systems, tools and techniques into their most frequently applied corresponding areas in the revised HCVC framework as depicted in Figure 4 and Table 7 respectively below.

As shown in Figure 4 below, it can be inferred that healthcare organizations are heavily investing in current and emerging IT-enabled A&BI systems, tools and techniques in their support activity domain of their value chain network than they are in the primary activity domain of the network. Examples of IT-enabled A&BI techniques currently being used or explored to create value include clustering analytics on disease types or patient population using different techniques such as hierarchical clustering, k-means clustering, etc. Process mining analytics to analyze and study patients' claims data using fuzzy logic or neural network technique is another technique being used in the support activity domain of the value chain. Additionally, analysis of log data which involves sequentializing of events analytics to discover historic patterns from data using visualizing tools such as Tableau, Microsoft Power BI, and Qlikview are also becoming common. Finally, abstraction and selection analytics such as pattern abstraction, temporal abstraction, activity mining of treatments and their effects on patients are other IT-enabled A&BI techniques that are becoming prevalent in the primary activity domain of the value chain network of healthcare organizations.

The results of mapping A&BI systems, tools, and techniques into the various areas in the revised HCVC framework were then sent back to the interviewees to validate and about 90% confirmed the final framework captures all their response to the interview questions.

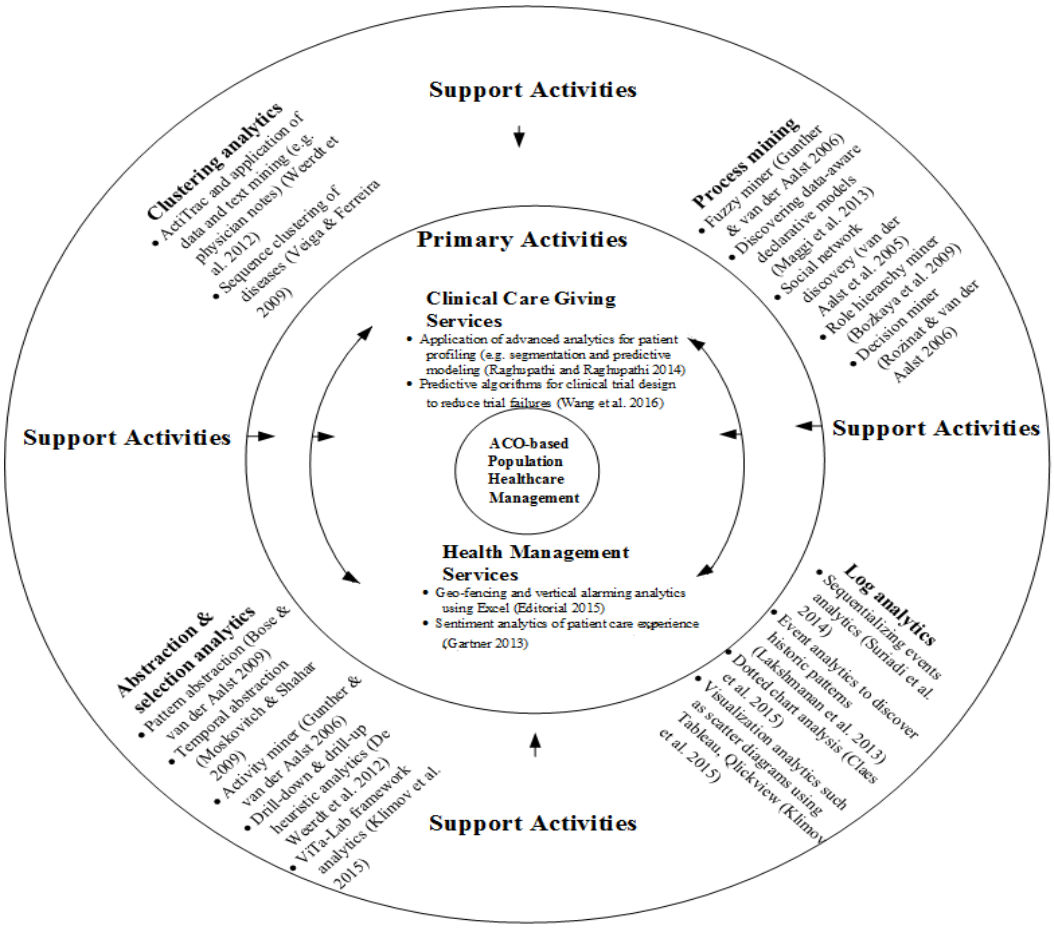

Figure 4. A&BI Systems, Tools and Techniques within the Revised HCVC Framework

Contrarily, investment in A&BI is minimal in the primary activities of their value chain network as very few techniques were discovered in this domain of the value chain network of healthcare organizations. For the clinical care giving category within the primary activity domain, it was discovered that predictive analytics techniques using predictive algorithms and clinical trial experiment to disease diagnostics and treatment is most rampant techniques. On the other hand, we found that healthcare organizations have begun exploring prescriptive analytics techniques that utilizes social media or unstructured data about patients' behavior within their social and natural environment. These analytics techniques, such as sentiment analysis, enables management of healthcare organizations to remotely monitor patients and indirectly influence their decisions by prescribing healthy living activities such as regular exercises, eating healthy, etc. Table 7 below is a summary of analytics systems, tools and techniques currently being used to drive value creation and delivery.

Primary Activities	Clinical Care Giving Services	***Healthcare systems***: application of advanced analytics techniques (e.g. segmentation and predictive modeling) to proactively identify preventive care beneficiaries (Raghupathi and Raghupathi, 2014) *Skilled nursing facilities*: clustering analysis to decongest ER facility; interactive visualization of care giving processes (Chen, Chiang and Storey, 2012) ***Telehealth***: device or remote monitoring applications to capture and analyze near real-time patients' behavior and reactions to treatments or test trials (2016). *Diagnostic practices*: predictive algorithms for clinical trial designed to reduce trial failures (Wang, Kung and Byrd, 2016) ***Transition of care***: analyzing disease patterns and tracking disease outbreaks through public health surveillance and speed response optimization mechanisms. This helps facilitate patient adjustment processes to new care environment (Raghupathi and Raghupathi, 2014). ***Monitoring systems***: using A&BI tools such as Tableau and Qlickview to monitor adherence to drug and treatment regimens, and detect trends that lead to individual and population wellness. ***Health education***: network analysis techniques to help create awareness and disseminate healthy lifestyle habit. Patient behavior and sentiment analytics to describe and predict patient activities and preference (Gartner 2013).			
	Health Management Services	Social activities Sentiment analysis of patient care experience Patience profile analytics using predictive modeling to identify vulnerable locations for disease contamination.	Physical activities Physical services improvement through optimal practice management using relative value unit (RVU) analytics (Corbin, and Strauss, 2008).	Environmental effects Geo-fencing and vertical alarming analytics using Excel Event analytics to discover historic patterns (Lakshmanan, Rozsnyai and Wang, 2013).	Economic influences Clinical operations analytics to identify more clinically relevant and cost-effective ways to diagnose and provide treatment to patients (Raghupathi and Raghupathi, 2014)

Support Activities	Technological support ActiTrac and application of data and text mining on documents such as physician notes (De Weerdt, Caron, Vanthienen, and Baesens, 2012). Visualization analytics such as cluster diagrams using Tableau, Qlickview (Klimov, Shknevsky and Shahar, 2015). Dotted chart analysis: a fast tool for visualizing the spread of an event such as contagious diseases (Claes, Vanderfeesten, Pinggera, Reijers, Weber and Poels, 2015)	Administrative Support Decision mining application to identify cost-effective possibilities for disease treatment and cost savings for patients (Rozinat and van der Aalst Scatter, 2013) diagrams representing visually specific measurements of patients on a relative time scale (Klimov, Shknevsky and Shahar, 2015).	Leadership Support Role hierarchy miner to discover and match employees talents with roles (Bozkaya, Gabriels and Werf, 2009). Discovering data-aware declarative process models which combines both case and process data to predict future events (Maggi, Dumas, García-Bañuelos and Montali, 2013)	Other Stakeholders (e.g. gov.) Pattern and temporal extraction: data mining techniques for classification and segmentation of patients and diseases (Bose and vander Aalst, 2009) Fuzzy miner: a technique for creating a process map that automatically cluster activities (Günther and van der Aalst, 2006).
	Table 7. Summary of Exemplar A&BI Systems, Tools and Techniques			

The reason for the high investment in IT-enabled A&BI systems, techniques and process in the support activities of the new value chain activities of healthcare organizations can be attributed to the paradigm shift in terms of focus on care delivery. Based on the current healthcare delivery act, healthcare organizations are currently being more proactive and agile by providing care and services that are geared towards reaching the healthy masses of the population with advanced technology-driven systems, techniques and processes. Hence, the increasing trend in investment on information technology-driven analytics and business intelligence systems that will enable management of healthcare organizations remotely monitor and influence decisions of their consumers. This is expected to enable them cut cost on care delivery and services that have in the past been predominantly provided within hospital and care facilities, reduce emergence room (ER) congestion, and avoid penalty payment to government and other stakeholders by ensuring consumers continue to live healthy and are continuously provided with services and recommendations that will keep them from coming to the hospital for treatment.

STUDY IMPLICATIONS

Practical Implications

This study contributes in many ways to healthcare practice by first developing a revised healthcare framework that is more current and clearly depicts contemporary healthcare value creation and delivery process that is predominantly driven by IT-enabled A&BI. In this regard, healthcare managers with growing interest in increasing IT investments should consider systems that easily facilitate remote communication and engagement with the healthy majority of people in their communities. Viewing the current healthcare delivery practices through the lens

of the revised HCVC framework can help reduce the confusion around this process and bring more clarity to the value creation mechanisms.

In addition, the revised HCVC framework can be used to facilitate quality of care delivery, as well as offering better services to both healthy consumers and sick patients who need physicians' attention. This study's findings imply that effective value creation and delivery in current healthcare organizations rest on effective use of information technology and other information system related elements such as A&BI. These elements either directly or indirectly affect the awareness of value creation, motivation to act or respond, and the capability of healthcare organizations to act or respond proactively. By consciously evaluating the ways IT-enabled A&BI systems and applications can be used to reach the masses of the population through effective flow of information, managers can avoid bottlenecks and anomalies across competitive value creation process that may hinder the opportunities to deliver quality of services to consumers.

Moreover, while this study's findings are mostly explanatory, they are also prescriptive. Thus, this research uncovered the notion that IT is indeed significantly transforming and reforming current healthcare delivery process from being hospital-focused to community-based caregiving. As a result, there has been a paradigm shift from the traditional way of value creation which used to be predominantly focused on how best to use hospital facilities and resources efficiently to deliver quality care, to how A&BI can effectively be utilized to remotely track consumer health behavior.

Theoretical Implications

Whiles several studies have sought to explain the mechanisms through which most organizations create and deliver value to their consumers, only few studies have focused on investigating how healthcare organizations are creating and delivering value especially through IT-enabled A&BI systems. By using a case study approach to conduct a field study to investigate how IT-enabled A&BI is impacting healthcare value chain activities, this study helps discern how IT employees as well as managers collectively view the current process of value creation and delivery, and the integral role played by IT and BI in that process. The revised HCVC framework depicted in Figure 3 can be used to explain, evaluate, or anticipate the role of IT in contemporary value creation and delivery processes healthcare organizations now go through. By using interview data, this study helps gain granular insight into IT-enabled A&BI value creation process and why it is important for healthcare organizations to adapt to this emerging process.

Also, by providing evidence for, and then revising the HCVC framework to demonstrate how healthcare organizations are currently creating and delivering value, this study serves as a gateway and spur further research into this area. This can result in providing a foundation for further explanatory or theory developing research in terms of qualitative studies and theory validation in quantitative research. Furthermore, this will not only help better inform research in healthcare but also help inform value chain maturity research within organizations in other industries.

Lastly, the study contributes to both IS and healthcare value creation streams of literature. Although prior research have primarily examined visible, detectable sources of value, no study has yet examined the processes that healthcare organizations go through in creating and delivering value to their consumers. This study is the first to evidently show the processes by which such value creation activities are carried out in the cotemporary healthcare context.

Most IS and healthcare research has, until now, assumed linear and hierarchical process by which healthcare industry creates and delivers value specifically within healthcare facilities such as hospitals, nursing homes, ambulatory services, etc. However, value creation and delivery nowadays goes beyond that which is realized solely through these facilities. That is, healthcare organizations are now proactively reaching out to even the healthier people within the communities through IT-enable A&BI with the aim of helping them to continue to stay healthy. By providing this revised HCVC framework, this research provides a holistic or much broader view of how healthcare organizations value creation spun beyond the traditional facility-based approach to creating and delivering value.

LIMITATIONS AND FUTURE RESEARCH

It is important to admit that the study has some limitations that can potentially be viewed as fertile ground for future research. First, the revised value chain framework for population health that was developed from this research is so tied to the data that the resultant outcome is likely to be consistent with empirical observation. However, large-sample, statistically generalizable studies are needed to test specific aspects of the framework.

Second, the resultant framework was developed through an in-depth examination of the contemporary value creation and delivery process carried out within a single but yet large healthcare organization. In this regard, the nature of value creation and delivery in this organization, and its particular utilization of IT in the process to create and deliver value through primary and support activities might not be the same for every firm. It is therefore important that large-scale studies that involve multiple organizations are carried out in the future in order to sharpen generalizability and further our understanding of the role of IT-enabled A&BI in this complex process.

Third, IT is being used to extend the traditional cognitive, temporal, and spatial boundaries on value-based decision making. Furthermore, managers are utilizing IT to objectively evaluate value creation alternatives and make certain rational decisions. However, more research is needed to fully understand how IT-enabled A&BI capabilities are created within healthcare context and how these capabilities can be fully leveraged in healthcare.

CONCLUSION

This study has examined how healthcare organizations value chain framework has significantly been impacted by the increasing adoption and use of information technology and related analytics and business intelligence systems. This has come about as a result of major changes in healthcare delivery services now aimed at keeping the population healthy and away from hospital facilities. Using open-ended semi-structured interview in a large healthcare organization with five affiliate care providing organizations, it was discovered that the existing HCVC framework is currently outdated and hence, there was a need to revise and update the framework to meet the current healthcare organizations' care delivery practices and regulation.

Consequently, a revised framework is empirically provided using findings from interview responses gathered from 30 interviewees comprising of health IT employees, healthcare executives, physicians, nurses, and other clinicians. The revised HCVC framework is more reflective of how healthcare organizations are currently creating and delivering value to consumers by remotely engaging the general population using IT to ensure that consumers stay healthy so that they don't have to go to the hospital for care services. The revised framework also showcases which specific IT enabled analytics and business intelligence systems, techniques and applications are currently being applied within various domains of the HCVC framework.

It was also discovered that healthcare organizations are now investing more in IT-enabled A&BI in the support activity domain of their value chain framework than they are in the primary activity domain. The fundamental reason for the high investment in IT-enabled A&BI systems, techniques and process in the support activities of the new value chain activities of healthcare organizations can be attributed to the recent shifts in focus on care delivery. As a result, healthcare organizations are currently investing more on IT-driven A&BI systems in order to be more agile and proactive in providing care and services that are geared towards reaching healthy masses of the population.

This revised HCVC framework will contribute significantly to both literature and practice. In the case of academia, the revised framework opens a great deal of research opportunities to refine or test the model. For healthcare practice, the revised framework will serve as a guide to other healthcare organizations that are currently in the process of transitioning from the old system or framework of value creation and delivery to the new system of care delivery.

One major limitation of this study is that respondents come from a single, yet large healthcare organization. In order to enrich the findings as well as for generalizability to other healthcare organizations of diverse characteristics, replicating this study across various healthcare organizations is warranted.

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APPENDIX A: INTERVIEW PROTOCOL

STUDY INTRODUCTION

This paper presents a mapping of the business analytics (BA) capabilities of a firm from a value chain lens similar to Porter's (2001) internet capabilities framework. The generally accepted classification of analytics: descriptive, predictive and prescriptive, is used as basis for mapping BA capabilities. Using an extensive search of the academic and practitioner literature, analytics applications were analyzed and mapped onto the value chain framework. Given the increased interest and investment in BA, it is important to have a good understanding of what analytics capabilities firms use to enhance value through its value chain activities. We illustrate exemplar uses of BA applications, tools and technologies used by firms.

Research questions:

1. What BI&A techniques and tools are organizations using within their value chain?
2. How are analytic capabilities being applied in different value chain activities of a firm?
3. What benefits are organizational value chains deriving from the analytic techniques and/or technologies implemented?

INTERVIEW PROTOCOL

Sections of Interview:

_____ A: Interviewee Background Information

_____ B: Strategic Alignment of Analytics and Business Activities

_____ C: Understanding Current State of Analytics, Tools and Techniques

_____ D: Benefits and Challenges from Analytics Use

Other Matters
Discussed: _____

Post Interview Comments or Leads:

_____

A. Interviewee Background Information

1. How long have you been . . .
_____ at this organization?

_____ in your present position?

2. What is your highest level of education? _____

3. What is your role? _____

4. Organizational reach/size

___Regional ___State ___National ___Multi-National

B. **Phase I: Strategic Alignment of Analytics & Business Activities**

5. At what level in your organization does Analytics "thought leadership" reside?

6. How does your company's Analytics strategic planning aligns with your current

i. IT activities: _____

ii. Business activities: _____

7. Why do you incorporate Analytics in your organization's strategic planning?

_____

8. What is your vision or motivation for adopting Business Analytics strategy in your organization? _____

9. Why would your organization hire a Chief Analytics Officer?

_____

10. If you could give me questions on why organizations use Analytics, what would they be?

_____

C. Phase II: Understanding Current State of Analytics, Tools & Techniques

11. How does your organization currently carry out its Analytics activities?

_____

12. Can you please provide some perspective about the type of data you collect/store/analyze?

Structured: _____

Unstructured: _____

Semi structure: _____

Probe: do you collect other data such as voice, images, videos, etc.?

_____

13 What type of analytics tools/techniques does your organization use in performing the following activities?

Admissions: _____; Care: _____; Discharge: _____; Marketing/Sales: _____; Service: ____;

Hospital Administration: _____

Information Services: _____

Diagnostics & Therapeutic Services: _____

14. Does your organization currently perform any of these types of analytics activities?

Descriptive: _____

Predictive: _____

Prescriptive: _____

15. Does your organization perform real-time analytics or ad-hoc-based analytics?

_____

D. Benefits and Challenges from Analytics Use

16. How can your organization derive value from Analytics use as it applies to the following?

improving quality of care: _____

improving financial performance: _____

17. Can you please highlight any challenges your organization is currently facing as far as Analytics use is concerned?_____

Post Interview Suggestions/Comments/Remarks:

APPENDIX B: Codes Used

Table 7: Initial Codes Used.

• Analytics • Intelligence • Business intelligence (BI) • Analytics & Business intelligence (A&BI) • Capability • Analytics projects • Business intelligence projects • Top manageent • Top management leadership • Leadership • Top management commitment • Commitment • Top management support • IT business alignment • Strategy • Value • Project success • Project objectives • Support • Data • Big data • Data warehouse • Efficiencies • Business applications • Technology application • Analytics techniques • Data science • Business insight	• Satisfaction • Success • Communication • Open communication • IT project • Business project • Accountability • Team membership • Organizational goals • Organizational performance • Organizational performance improvement • IT involvement • Involvement • Training • Descriptive analytics • Predictive analytics • Prescriptive analytics • Proactive • Insight • Information • Decision support • Decision making • Business use case • Business analyst • Financial performance improvement • Discovery • Structured data • Unstructured data	• Interactions • Dedicated employees • Project culture • Collective goals • Challenges • Implementation • Success • Process improvement • Chief Information Officers (CIOs) • A&BI organizational management capability • A&BI planning • A&BI investment • A&BI coordination • A&BI control • A&BI talent capability • A&BI technology management knowledge • A&BI technical knowledge • A&BI business knowledge • A&BI relational knowledge • A&BI technology capability • A&BI connectivity • A&BI compatibility • A&BI modularity • A&BI capability