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The Effects of Information Technology Processes On Computerized Clinical Decision Support Systems

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THE EFFECTS OF INFORMATION TECHNOLOGY PROCESSES ON COMPUTERIZED

CLINICAL DECISION SUPPPORT SYSTEMS

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Abstract

One of the most significant challenges facing healthcare executives today is investing in clinical

decision support systems (CDSS) that can support diverse data and decision making needs of

physicians and managers to accomplish their organization's mission. The Health Information

Technology for Economic and Clinical Health Act provisions of the American Recovery and

Reinvestment Act economic stimulus package have brought billions of dollars in incentive funds

for CDSS and other healthcare information technology. CDSS can help healthcare organizations

automate inefficient processes, lower costs and improve patient care with better decision making.

Risks, however are that pre-implementation and customization of CDSS can be costly and the

systems are difficult to measure return on investment. Furthermore, some studies have suggested

that the promised benefits of these systems can be difficult to achieve. This document

investigates linkages between CDSS and organizational performance. It examines academic

literature, develops a research methodology and presents findings from a study in the healthcare

industry.

Acknowledgements

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Chapter 1 – Introduction

The support of business decision making has been one of the main thrusts of the business use of information technology (IT). This is especially important in the healthcare industry. Hospitals have invested heavily into technologies that bring about greater operational efficiency, improvements to patient-centric services and promotion of preventative care. A top investment priority for many healthcare organizations has been clinical decision support systems (CDSS). These organizations hope to leverage not only the improvements to quality of care and efficiency that are derived from CDSS use, but also achieve better decision making. Driving the move to CDSS is the 2009 American Recovery and Reinvestment Act (ARRA) economic stimulus package, which allocated billions of dollars in incentive funds for CDSS and other healthcare information technology (HIT). However, researchers and practitioners have noted that investments can be formidable and the return on investment (ROI) questionable. Additionally, these systems need to be aligned with business strategy and require project management skills. This chapter identifies the technology, discusses the key trends driving CDSS and the impact of legislation, including ARRA. It also focuses specifically on the benefits and implementation challenges. Finally, in this chapter, a hypothesis is suggested, which will be tested by interviewing leaders involved in CDSS projects. The hypothesis states that improved IT processes associated with project management could enhance the success in these challenging projects.

Healthcare, CDSS and Organizational Performance

The Healthcare Information and Management Systems Society defined clinical decision support systems (CDSS) as "a clinical system, application or process that helps health professionals make clinical decisions to enhance patient care." In healthcare, the range of these systems and related impact are vast. For example, Isabel is a pediatric CDSS tool used by hospitals to query diagnoses (Intute, 2003). The tool interfaces with multiple applications including one used to store clinical data called an electronic medical record (EMR). Isabel allows healthcare professionals to input a set of clinical parameters (i.e., patient's age, gender, symptoms) and returning test results, x-rays and a list of potential problems the patient might have based on the input (Isabel Healthcare, Inc., 2010).

Other types of CDSS exist. The computerized provider order entry (CPOE) is used for practitioners to electronically enter orders (i.e., prescriptions or tests) to treat patients. Columbus (Ohio) Children's Hospital uses a CPOE system to eliminate legibility problems with prescription and to provide guidance to physicians as they place their orders such as low dosage alerts (RedOrbit, Inc., 2005). Similarly, 65 hospitals in South Carolina use a CDSS to manage public health emergencies such as a bioterrorism event or pandemic outbreak (Logical Images, Inc., 2010).

A final example is what a hospital in South Korea refers to as their "smart hospital" which interfaces with applications to diagnose patients, monitor drugs, send alerts associated with prescriptions and schedule tests or procedures (Chang, K. et al., 2010; Chang, 2008). The CDSS has improved the value of their healthcare by reporting instances of inaccurate billing and adverse drug events (ADE−harm from drugs administered) and also decreased the time spent by healthcare professionals diagnosing patients in the emergency room (ER).

The benefits of CDSS are reflected in the market projections. Frost & Sullivan, a leading

market researcher, projected that CDSS sales in North America and Europe will reach $364.1

million in 2016, up from $137.5 million in 2009 (Canon Communications Pharmaceutical Media

Group, 2010; Frost & Sullivan, 2006). CDSS were forecast to see increased use in alerts and

reminders, diagnostic assistance, image recognition and therapy planning and critiquing. The

factors that affect these projections are the effectiveness of implementations and end-user

acceptance to use the technology.

There seems to be a perfect alignment of drivers to support a CDSS investment. A key

driver is the American Recovery and Reinvestment Act (ARRA). The primary goal of ARRA is

to supply tax relief to individuals and businesses with the thought of rebuilding infrastructure in

America (i.e., roads, schools, and waterways). It is also aimed to create and preserve "3.5

million jobs" (Hitt, 2009). The stimulus funds are also intended to promote innovation and

quality of jobs by increasing "federal support for research, technology and innovation for

companies and universities" (Obama-Biden Transition Project, 2010). This includes allocating

funds to encourage wide spread use of wireless broadband technology.

A part of ARRA focuses on improving health care quality and efficiency by providing

funding for health information technology (HIT). "This includes incentives such as hospitals

receiving "as much as $11 million−if they show they have computerized their medical-records

systems" (Hitt, 2009). The Obama administration stated that HIT and other reform measures

will "make healthcare more affordable, make health insurers more accountable, expand health

coverage to all Americans and make the health system sustainable, stabilizing family budgets,

the Federal budget and the economy" (The White House President Barack Obama, 2010, para.

2).

One of the ways national health insurance will be made more affordable is by making the healthcare industry more accountable with regulation and better record keeping (i.e., preventing "insurance industry abuses and denial of care") (The White House President Barack Obama, 2010, para. 3). A way to do this is to electronically update records through use of CDSS. ARRA also included increased health coverage for Americans (95 percent) (The White House President Barack Obama, 2010). It is common knowledge that covering the uninsured usually falls onto the hospital. This is especially true with emergency room (ER) care. That is why implementing systems, which decrease the time it takes to diagnose patients, means less cost for the hospital if patients are spending less time there.

Another driver to implement CDSSs, tied into healthcare reform, is stimulus funding and associated rules to qualify for these grants. This is because healthcare providers will have to implement HIT quickly if they wish to receive ARRA HIT rebates (paid through increased Medicare and Medicaid payments). The ARRA was enacted by Congress in February 2009 and dedicated roughly $787 billion in funding—with a goal of helping to stimulate a struggling US economy and pushing the country toward economic recovery (US Government Printing Office, 2009). Healthcare was a major focus of ARRA. "The HIT sections of the ARRA law go under the acronym 'HITECH'" which stands for the Health Information Technology for Economic and Clinical Health Act (Health Information and Management Systems Society, 2010b, p.1). The act "reshapes the regulation of the privacy and security of patient health information" by adding additional regulation under HIPAA (Healthcare Information and Management Systems Society, Chicago, 2009a, p.1). This includes regulation of businesses. For example, rules originally applied *indirectly* to healthcare organization's business associates whereas now these rules apply *directly* to associates. Under the act, healthcare organizations must report data security breaches

of patient data unless lost files were encrypted (as per federal standards). Additionally, the

federal government will conduct security audits to ensure compliance.

One way for healthcare providers to be reimbursed for HIT spending is through the return

on investment (ROI) generated by using CDSS; this is especially true with the 2010 Patient

Protection and Affordable Care Act (PPACA as part of ARRA). This act affected *"insurance*

related provisions" such *"*Medicaid eligibility, insurance premiums, business healthcare benefits,

coverage and claims based on pre-existing conditions and health insurance exchanges. It also

affected HIT addressing "challenges" with "electronic health information exchange (HIE)"

(Health Information and Management Systems Society, 2010a, p.1). These provisions are: 1)

improve the quality of healthcare by increasing quality data collected by HIT, creating new HIT

programs and giving payments to existing entities for the use and improvement of HIT, 2) new

operating rules and standards that will directly or indirectly control the use and innovation of

HIT and 3) increase the size of the HIT workforce across different sectors (Health Information

and Management Systems Society, 2010a). Under the provision of improving quality, many

healthcare organizations are required to report quality measures (i.e., improved health of patients,

HIT performance information) to Health and Human Services (HHS), related federal committees

and also the public. Further incentive for healthcare organizations to report these data are to

prove their organization's HIT is performing to government standards to receive grant funding

with the exception of select facilities (i.e., long-term and mental healthcare). The standards are

called "meaningful use." To be eligible for the funding, hospitals must prove they are using HIT

in a "meaningful manner which includes exchanging electronic health information to improve

the quality of care" and "submitting clinical quality measures" and others (Healthcare

Information and Management Systems Society, 2009b, p. 1).

The criterion is still being determined by the HHS; however, an international organization providing global leadership for the optimal use of HIT is the Healthcare Information and Management Systems Society (HIMSS). The group provides numerous suggestions for meaningful use criteria including how systems should be installed, various system components that should be implemented and also various HIT reporting functional requirements. For example, HIMSS stated that healthcare providers who wish to receive funding should possess a certified and functional electronic health record (EHR−digital patient medical information designed to be shared) that can inoperably share patient standardized data (Healthcare Information and Management Systems Society, Chicago, 2009b). The group also suggested (directly pertaining to the thesis), that providers should implement a CDSS that provided "clinicians with clinical knowledge and intelligently-filtered patient information to enhance patient care" and also "capabilities to support process and care measurement that drive improvements in patient safety, quality outcomes, and cost reductions" (Healthcare Information and Management Systems Society, Chicago, 2009b. p. 2).

Once criterion is determined and HIT is implemented, healthcare organizations can be evaluated if their systems meet the standards through the use of CDSSs. For example, system security can be assessed by comparing un-matched data electronically using decision support. Also directly related to CDSS is quality reporting. Under PPACA, the government will share CDSS findings with HIT vendors so that this information can be used by clinical practices in "timely and efficient manner." One way the information will be shared is through government training of healthcare organizations on topics such as effective ways to implement HIT and how to meet the increased demand and management of IT professionals.

HIT performance is also important to access improvement of patient health on a continual basis. This is done through various PPACA programs that utilize the data health organizations are required to report to the government as part of the law. These data can be collected through the use of CDSS. One such example is a program that established "competitive and affordable community health insurance options" (Health Information and Management Systems Society, 2010a, p.2). CDSS can be used to this end by tracking instances of "fraud and abuse" (Health Information and Management Systems Society, 2010a, p.2). Another example is programs providing medical assistance individuals using home-based care (i.e., chronic patients) and the self-managed care of healthy patients. CDSSs can be used for various tasks in this endeavor including drug monitoring and e-mail reminders to encourage patients to adhere to their providers' recommendations or indicate when it is time for tests or procedures (i.e.; Papanicolau tests, tetanus shots).

In addition to the goal of improving the patient health, PPACA is intended to simplify billing and administration. There are PPACA rules concerning the eligibility, payment and claims status of patients. One way these guidelines relate to decision support, is through the standardization of names for billable procedures or diseases and these terms can be extracted.

An additional driver to implement CDSSs, related to healthcare reform, is increased access to affordable drugs. Part of the healthcare legislation is providing physicians and patients "access to effective and lower cost alternatives" of drugs. (The White House President Barack Obama, 2010, Title VII section, para. 1). This will be done by prohibiting "anti-competitive behavior by drug companies that keep effective and affordable generic drugs off the market" (The White House President Barack Obama, 2010, Title VII section, para. 1). To this end,

CDSSs can be used to alert practitioners of pharmacologically equivalent drug alternatives to prescribe to patients.

Increased focus on patient care is another incentive to implement CDSSs. "The new regulation expanded new consumer protections to all Americans with health insurance, moving [the US] toward the competitive, patient-centered market of the future" (The White House President Barack Obama, 2010, Title I: Keeping the plan you like section, para. 4). These protections include not only insuring those not able to afford medical insurance, but also ones with pre-existing conditions (The White House President Barack Obama, 2010, Title I section, para. 5). To offset this cost, the legislation aimed to attack "disease before it hits" in order "to improve health, save lives and avoid more costly complications down the road" (The White House President Barack Obama, 2010, Title I: Keeping the plan you like section, para. 4). This will be done by proactive care activities such as offering "preventive care and immunizations at no cost" (The White House President Barack Obama, 2010, Title I section, para. 5). One example of CDSS, useful in proactive care, is reminder systems that alert patients when it is time for their scheduled vaccinations.

Supporting an aging population is another healthcare reform driver to implement CDSS. As a result of the Baby Boomer's retiring (born from 1946 to 1964), an older patient population means more chronic conditions, frequent patient visits to their practitioner and increased volume of prescriptions (SlideShare, Inc., 2010). The ratio of retired Americans versus healthcare workers means there will be a decreased number of professionals in the healthcare workforce to address the need.

Fulfilling the demand and the cost associated with serving a large, aging population can be done by leveraging CDSS. These systems can be used to automate tasks such as prescribing

and diagnosing, to make better decisions, to provide customized and patient-centered care to those with special conditions (i.e., chronic), to promote accurate billing and also to measure the effectiveness of all of these activities in order to streamline processes in healthcare.

A summary of the potential benefits of CDSS are: reducing medical errors and increasing accessibility to "up-to-date" documentation (DSS Success Factors, 2005, Potential benefits of CDSS section, para. 2). An example of reduced medical errors is CDSS used with CPOE because these alert the physician when they input incorrect dosages while prescribing medication. An example of the second benefit is systems for diagnosis, which are designed to receive input data about a patient thus returning a set of best practices in the form of heuristics to help the practitioner decide what the best "course of action" is to pursue (Case Western Reserve University, 2010, MD benefits of the clinical information system section, para. 4).

Implementation Risk Considerations

Implementing CDSS can be risky. Lack of standards is one risk implementing CDSS. A summary of a report on CDSS from the Leapfrog Group, stated "the major factor limiting the full adoption and impact of CDSS is the lack of a common and transportable base of clinical knowledge and clinical decision support interventions that can be easily and widely used in electronic health records and other clinical information systems" (Canon Communications Pharmaceutical Media Group, 2010, para. 6).

Reference data quality also contributes to the effectiveness of CDSS implementations. A 2006 study, analyzing the effect of data quality on the accuracy of CDSS, stated that the accuracy and completeness in medical registries may be as low as 67 percent and those issues of data quality have an effect on the system accuracy (Hasan, & Padman, 2006). The primary finding of the study, via a simulation technique, was that the accuracy of information entered

about the sex of a patient in particular caused the widest variance of output. For every one

percent decrease in the quality of the data element, there was a corresponding eight percent

decrease in the accuracy of the CDSS (Hasan, & Padman, 2006).

Because of a lack in needed information, clinicians are usually distrustful of CDSS. A

report on CDSSs reinforced this point; stating that although computerizing "clinical data and

transactions can substantially develop information management in patient care, CDSS reaches its

full potential only when relevant clinical knowledge is combined with the data to take informed

healthcare decisions and actions" (Canon Communications Pharmaceutical Media Group, 2010,

para. 4).

Another review of CDSS stated that that many unanswered questions exist (Wright, A., &

Sittig, D., 2008). These not only defined what reference data healthcare professionals would be

responsible for keeping up to date, but "who would be liable for the decision support rules and

guidelines" (Wright, A., & Sittig, D., 2008, p. 646).

Besides liability, clinicians resist the use of CDSS for fear that these could reduce

autonomy (Canon Communications Pharmaceutical Media Group, 2010, para. 6). A 2009 book,

about the adverse consequences of HIT, stated that physicians historically were allowed to be

autonomous (i.e., "one's actions are one's choices") because they were regarded as the "ultimate

decision makers" (Sittig & Stead, 2009, Chapter 5, pp. 80-81). The text stated that this

independence is currently challenged due to the adoption of CPOE and similar CDSS

technology.

End-users are usually less resistant to CDSS, if implemented with standards. This was

reinforced by the Wright & Sittig review of CDSS. It said that "the use of standards to represent,

encode, store and share knowledge overcomes many of the disadvantages of [CDSS] because "it

provides a method for sharing the decision support content, and separates the code describing such content from the code which implements the clinical information system" (Wright, A., & Sittig, D., 2008, p. 646). However, the authors admit that "there are often too many standards to choose from; several dozen standards are available to represent simple alerts and reminders" and that these standards limit the ways programmers create future additions and customizations to the code (Wright, A., & Sittig, D., 2008, p. 646).

Another implementation concern is budget. The primary cost associated with CDSS is the installation of EMR and CPOE technologies required to be in place before the system can be added. Stimulus funding reduces the risk of expensive implementation costs, especially if a detailed ROI plan is prepared before investing. Planning is also essential in terms of stimulus funding because if the organization cannot prove the system meets the meaningful use criteria, it will receive only a portion of the funding. Additionally, HIT systems can take a long time to show ROI (i.e., ten years). One such example was a CPOE system from Brigham and Women's Hospital (BWH) from Boston. "Over ten years, the system saved BWH $28.5 million for [a] cumulative net savings of $16.7 million and net operating budget savings of $9.5 million given the institutional 80% prospective reimbursement rate" (Kaushal et al., 2006, p. 261). One literature review from 2003, accessing the ROI of EMR found return in as little as five years reporting an average net benefit of "$86,400 per provider" (Wang et al., 2003, p. 397).

Depending on how many features are added, once EMR and CPOE are in place, the cost CDSS can be minimal. For example, CDSS used "for ordering blood tests in primary care" were implemented at "118 practices throughout the Netherlands" (Poley, Edelenbos, Mosseveld, van Wijk, de Bakker, van der Lei et al., 2007, p. 213). It was found that "total intervention, comprising development costs and installation costs, amounted to €79,000 (€670 per practice)"

(Poley et al., 2007, p. 213). This is equivalent to $97,888.90 and $830.20 in today's US dollars (respectively).

The ongoing implementation of alerts can significantly affect development and maintenance costs. Currently, there are increasing complaints, in the healthcare community, that CDSS are producing too many or not enough alerts. A blog comment, on a HIT corporation website stated, that "alerts may come at inefficient times in the workflow or they may interrupt workflow making them annoying rather than helpful" (Tomsik, 2010, Drug safety section, para. 1). Another blog comment on the same website admitted that healthcare professionals often complain there are too many alerts used in HIT systems (i.e., meaningless drug interactions and duplicate therapy alerts) (Madjerich, 2010, Alert fatigue is not the only enemy section, para. 1). One study, conducted from 2008-2010, of the CPOE systems used in US hospitals, found that the alternative is not enough alerts as 52 percent of 10,447 medication orders alerts at 187 hospitals failed to deliver (The Leapfrog Group, 2010). A study from 2008,   analyzing the cost of CDSS in the US and Canada, found that "the team required 924.5 hours and $48,668.57 in estimated costs to develop 94 alerts for 62 drugs" (Field et al, 2008, p. 466).

In addition to cost considerations, inadequate implementation preparation is another challenge associated with CDSS. As an increasing number of companies and institutions are developing these systems, they must make critical decisions regarding the information they include. To implement effective CDSS, it is optimal to first have a controlled medical vocabulary (CMV). This is "critical because it ensures that the practitioners who use the EMR are accessing accurate and comparable data. The CMV normalizes data from a relational and definitional hierarchy that enables other components of the EMR to optimally operate. It provides standard terminology to be used with the functional requirements (i.e., rules, order sets)

within the knowledge engine of CDSS, for the information accessed via "IF-THEN" statements.

Order sets are lists or arrays used in computing. IF-THEN statements are conditional statements

used in programming logic used in calculations and rules are such statements. For example, the

system can logically unite standardized terms related to diabetes (i.e., obesity and type 2) with

the statement, "if the patient is overweight, he is at risk for diabetes." "Without a functional

CMV, the clinical decision support system (CDSS) and workflow components of the EMR will

not perform as expected by the clinicians in the environment" (Garets & Davis, 2006, p. 3).

Systems must also be implemented effectively. Likely one of the reasons why the smart

hospital design (mentioned earlier in this chapter) was successful was because an evidence based

framework was used in the system (Chang, 2008). "Evidence based medicine is the

conscientious, explicit, and judicious use of current best evidence in making decisions about the

care of individual patients. The practice of evidence based medicine is "integrating individual

clinical expertise with the best available external clinical evidence from systematic research"

(Sackett, Rosenberg, Muir-Gray, Haynes & Richardson, 1996).

Implementing a system in this way is not easy because CDSS are complex to design. In

2007, a US paper published a top ten list of "grand challenges" concerning CDSS. The number

one challenge was to "improve the human–computer interface [HCI]" (receiving an average

score of "2.89") (Sittig, Wright, Osheroff, Middleton, Teich, Ash, Campbell & Bates, 2008, p.

391). HCI is the software and hardware used by the end-user to interact with the items displayed

on their computer monitor. The remaining nine challenges were (in order of importance):

"disseminate best practices in [CDSS] design, development, and implementation," "summarize

patient-level information," "prioritize and filter recommendations to the user," "create an

architecture for sharing executable [CDSS] modules and services," "combine recommendations

for patients with co-morbidities [co-morbidity is the presence of a disorder or disease],"

"prioritize [CDSS] content development and implementation," "create internet-accessible

clinical decision support repositories," "use [free text] information to drive clinical decision

support" and "mine large clinical databases to create new [CDSS] (Sittig et al., 2008, p. 391).

Due to cost, inadequate implementation preparation, poor implementation strategy and

the challenges associated with designing these complex systems, many CDSSs (and related

technology) projects risk failing. This results in projects that exceed budget and schedule

affecting the amount of studies available proving substantial profit. Perhaps this is why the

healthcare industry largely perceives HIT as inefficient causing low user acceptance rates. A

frequently cited example was a CPOE system developed in-house at Cedars-Sinai Medical

Center in Los Angeles. A small group of physicians protested the decision to make certification

in CPOE mandatory and they expressed their "anger and frustration" that entering orders took

longer with the technology than with the previous manual method (Ball, 2005, p. 64). As a

result, the medical center turned it off and went back to their former method of ordering.

In another Drexel University in Philadelphia filed suit (referred to as Drexel v. Allscripts

for the remainder of this document) against a team leader and two HIT vendors for failure to

provide a functional software product (Philadelphia Health & Education Corporation d/b/a

Drexel University College of Medicine v. Allscripts, LLC. and Medicomp Systems Inc., No.

001994, March 16, 2007). One of the university's faculty members, Scot Silverstein, maintained

a blog complaining about the inefficiency of HIT; describing interaction with these systems as a

"mission hostile user experience" and also that clinical data is often "scattered far and wide

making physicians and nurses go on wild goose chases" to find elements in the interface

(Silverstein, 2009, msg 1, para. 7). Other examples included diagnostic lists that "place rare

diagnoses near the top and common ones a hundred items below" "boxes that hide part" of these

diagnostic terms "leading to incorrect selections" and "duplicate test results posted in patient

EMRs," causing extra text to read and overall confusion (Silverstein, 2009, msg 1, para. 7).

Various surveys of CDSS admitted their potential, but also suggested that physicians

avoid utilizing the technology for various reasons. One of these reasons is the time it takes to

maintain "the knowledge base for decision support and training" (Ash, Sittig, Poon, Guappone,

Campbell, & Dykstra, 2007, p. 416). A 2007 paper found that the 82 percent of medical staff at

US hospitals believed system demands are "a moderate to very important problem" (Ash et al.,

2007, p. 420).

Physicians are also distrust CDSSs to make accurate decisions. This was true for a study

conducted in Ireland of general practitioners that found 22 percent believed there was a "lack of

convincing evidence" regarding the effectiveness of the system (Hor, O'Donnell, Murphy,

O'Brien & Kropmans, 2010, p. 5). Additionally, "about one in five respondents were concerned

that this mechanism may reduce their decision making power in prescribing" (Hor et al., 2010, p.

3). Additionally, "44 percent expressed concern regarding their degree of flexibility to override

the suggestions" or decisions made by the system (Hor et al., 2010, p. 4). Forty-six percent found

that the system was overly sensitive thus sending too many alerts, in the case of drug interactions

(Hor et al., 2010, p.1). Unrelated to functionality, participants found a "lack of a strategic

implementation plan [78 percent] for the system as the main perceived barrier to the

incorporation of CDS" into their clinical practice along with a "lack of financial incentives [70

percent]" (Hor et al., 2010 p.1).

Another problem with CDSS is the perception that these are counter-productive. In

general, the technology is designed to aid healthcare professionals to make better decisions.

However, multiple sources state these systems are instead propagating additional tasks and

mistakes as compared with former file-based methods. Most state a reduction in efficiency is

problematic for reasons of decreased attentiveness by physicians towards patients, adverse drug

events (ADEs−harm from drugs administered), identity theft, medical errors and ultimately

death. Medical errors are a major concern because these currently account for the eighth leading

cause of death in the U.S. (Ball, Garets & Handler, 2003). Perceptions of CDSS inefficiency

make it hard for IT leaders to garner support for funding, however usually related technology is

in place. For example, increased accessibility of patient records in the 1996 HIPAA legislation

has largely caused EMR technology to become the cost of doing business for healthcare

providers. This is because many organizations using file-based records switched to digital

during that time. However, the maintenance of EMR and CDSS can be costly to maintain.

Widespread use of EMR has led IT leaders to take advantage of ARRA stimulus dollars

adding CDSS that have the potential to provide their companies with competitive advantage.

However, if healthcare professionals continue to view these systems as ineffective, this

potentially life-saving technology risks being under-utilized resulting in lost healthcare dollars

and increased medical errors. That is why it is important to analyze problems associated with

these systems. A 2005 study by a group of physicians from Ontario reported that more research

needed to be done in this area (Garg et al., 2005). It found that positive surveys from end-users

were easier to find than cases where the patient benefitted directly as a result of CDSS. Out of

the 100 articles reviewed for the study, as many as 97 accessed practitioner performance (via

survey) while only 52 studies accessed instances where the patient benefitted. It is interesting

that within this batch of 52 trials, only seven or 13 percent reported improvements) (Garg et al.,

2005). Therefore, contributing to the shared knowledge related to CDSS is helpful to the

healthcare community. In considering the implementation risks that can occur, research was

undertaken that identified why those responsible for CDSS were less successful in development

and also reasons for times they achieve the preferred result.

Hypothesis: Project management is the key IT process explaining installation variances

among CDSS projects.

Methodology

To determine whether the hypothesis is true, a case study was conducted using a three

phase methodology. In the first phase, the researcher reviewed existing literature, both business-

IT alignment, HIT and in specific CDSS. In the second phase, a survey was developed based on

Luftman's top business-IT alignment criteria (five selected) asking participants to recall past and

present CDSS projects resulting in both efficient and inefficient systems. In the third phase, on-

site interviews were conducted with IT executives from Denver area hospitals and the data was

analyzed. Analysis was performed categorically and also by measuring the time specified topics

were discussed.

Conclusion

This chapter showed that CDSS are rapidly becoming a part of the healthcare

environment. These systems can be used for alerts and reminders, diagnostic assistance, image

recognition, and therapy planning and critiquing. It was explained that CDSS provide the

benefits of improved health for patients (i.e., preventative care, decreased ADEs), while at the

same time providing profit for hospitals (i.e., decreased stays for patients remain in hospitals and

increased revenue-generating tests and procedures).

This chapter also listed the drivers to implement CDSS: ARRA stimulus funding, greater

demand (i.e., increased coverage and senior population), new regulations (i.e., in respect to the

insurance and drug companies). A solution to the growing demand with increased cost is leveraging HIT. By automating tasks and measuring the effectiveness of these activities, a hospital can streamline processes such as the workflow in the ER to achieve effectiveness while saving revenue despite a decreased budget and staff.

This chapter also identified the risks associated with implementing a CDSSs, such as adding insufficient or too many alerts, insufficient clinical knowledge included in the tool, clinicians' fear of losing autonomy or being liable due to the system, a lack of system standards, ongoing costs associated with adding customizations, design challenges and overall preparation and strategy needed to implement these systems. A hypothesis was presented that will be tested through literature review and by interviewing executives responsible for IT and/or the medical IT at four Denver area hospitals about critical IT activities that result in a successful implementation of a CDSS. Interview questions were drafted based on concepts discussed in the next chapter, which comprises of a review of literature related to the CDSS and its role in strategic business-IT management.

Chapter 2 – Literature Review

As the field of business-information technology (IT) alignment has expanded, researchers have shown a growing interest in the entire strategic IT planning process to take full advantage of technology for competitive advantage. In healthcare, clinical decision support systems (CDSS) can help physicians make better decisions. But planning processes from concept to implementation are critical to ensuring CDSS successfully meet business needs. This chapter examines the role of strategic IT planning processes to leverage IT resources to ensure a competitive advantage and what processes need to be in place to minimize the risks to CDSS.

Business-IT Alignment Framework and Related IT Processes

Jerry Luftman (2004) defined business-IT alignment as "applying IT in an appropriate and timely way, in *harmony* with business strategies, goals and needs" (Luftman, 2004a). He says alignment addressed how: "1) IT is aligned with the business and 2) how the business should or could be aligned with IT" (Luftman, 2004a). Luftman described a *mature strategic alignment* to be "where IT and other business functions adapt their strategies together" (Luftman, 2004a). He believed a business should constantly access their level of maturity to ensure it is moving in the best direction. This is done by recognizing enablers and inhibitors to achieving alignment. Alignment is evaluated through Luftman's six strategic alignment maturity criteria: 1) communications maturity (sharing knowledge across the organization), 2) competency/value measurement maturity (exhibiting the value of IT, 3) governance maturity ("prioritization and allocation of IT resources"), 4) partnership maturity ("trust" between IT and the business, 5)

scope and architecture maturity (IT as a business driver) and 6) skills maturity (forgoing

traditional ideas attributed to company culture) (Luftman, 2004b). Alignment is accessed on a

scale from one to five (five being the most aligned and most organizations today are at level two

or above (Luftman, 2004b).

In business applications, the range and impact of business-IT alignment are vast. For

example, Wal-Mart has aligned with its vendors−Proctor & Gamble and GE Lighting (General

Electric Company) −by sharing daily sales information electronically about its products allowing

stores to restock their shelves on an "as-needed" basis (Luftman, 2004b, p. 31). Another

example is the McKesson Corporation, which has aligned its sales goals with the purchasing

goals of their customers (pharmacies). "McKesson ties the pharmacy's database into its intranet"

allowing sales representatives to demonstrate certain drugs McKesson offers that are

"pharmacologically equivalent" to other brands the pharmacies are currently stocking (Hartman,

Sifonis & Kador, 2000, Transform key processes section, para. 3). McKesson offers these

products for a fraction of the cost that their competitors do. Therefore, the pharmacy's goal of

selling more products is met while customers can purchase inexpensive drugs with the same

functionality.

Another example of the impact of strategic alignment is Cisco Systems, Inc., which

provides networking products and services. Because it outsources the manufacturing of some of

its key products, Cisco leverages the web to "seamlessly link its customers, prospects, sales

force, distributors and employees" (Luftman, 2004b, p. 32). This has worked so well that

"regardless of where a Cisco component is manufactured, customers view Cisco as one entity for

questions on orders, support, and network configuration" (Luftman, 2004b, p. 32). The

networking company also saves revenue on tech support by providing customer support and

information on-line. In fact, "80 percent of customer requests for technical support are electronically fulfilled and at levels of customer satisfaction that far surpass the days when these requests were manually handled" (Luftman, 2004b, p. 32).

IT literature is uniformly positive that the adoption of business-IT alignment can potentially produce successful IT implementations. Evidence comes from a longitudinal study conducted by business researchers from the US and Canada. The researchers sent out surveys in 1991 and 1995 to information systems (IS) executives and consultants from a variety of industries and found that "the alignment between business strategy and IS strategy is positively associated with perceived business performance" (Sabherwal & Chan, 2001, pp. 4, 15). Participants were asked to rate their companies on a five point scale of business performance attributes (i.e., "reputation among major customer segments," "technological developments," "market share," and "product quality") (Sabherwal & Chan, 2001, p. 19). The data was tested by "examining the correlation between perceived business performance and alignment" across business strategy by calculating the "Euclidian distance between each firm's IS strategy and the ideal IS strategy for the business strategy type to which it belonged" (Sabherwal & Chan, 2001, pp. 22-23). A smaller distance indicated that degree of alignment was higher. "The results for the whole sample were that "correlation between alignment and perceived business performance was a .019" supporting the business-IT alignment yielded not only project success, but company success as a whole" (Sabherwal & Chan, 2001, p. 24).

Another study surveyed 250 small manufacturing firms in the United Kingdom. Similar to Sabherwal & Chan, it asked participants to rate their company on factors that determine alignment using alignment variables (i.e., product quality, "product diversification" and "production efficiency") and company performance variables (i.e., "long-term profitability,"

"competitive advantage," "image and client loyalty") (Cragg, King & Hussin, 2002, p. 121). It

was found that organizations with high performance possessed "total IT alignment" values

consisting of either zero or negative numbers (Cragg et al., 2002, p. 121). Therefore, all the high

performance firms were also tightly aligned proving that strategic alignment is as important for

small firms as it is for larger firms.

A final study that measured business-IT alignment was from South Africa where

executives in the educational sector were asked to rate the success of factors that affected

alignment (i.e., business/IT planning, strategic IT planning, managerial resources and IT

planning success (Motjolopane & Brown, 2004). Results showed that strategic information

planning positively correlated with the factors of: managerial resources, business planning and

IT implementation success and alignment (Motjolopane & Brown, 2004). Additionally, IT

managerial resources positively correlated with the factors of: IT implementation success and

alignment (Motjolopane & Brown, 2004). Correlations can be used to conclude that the critical

factors of alignment are (in order of importance): the alignment of business planning with

strategic IT planning, IT managerial resources and IT implementation success (Motjolopane &

Brown, 2004).

Jerry Luftman laid much of the conceptual foundation for what became the study of

business-IT alignment. Luftman compiled a list activities that IT performs (based on existing

business frameworks) called the 38 IT processes (Luftman, 2004b, pp. 122-123). He indicated

that all of these processes affect alignment, but approximately 71 percent greatly affect it. The

significant processes are: application planning, multiple project management related processes,

strategy, architecture, multiple planning processes, vendor management and security/recovery.

After reviewing problems associated with CDSS in medical literature, this researcher selected

the following five processes to help explain why some organizations experience IT success while others may not: 1) business strategic planning, 2) IT processes associated with project management, 3) capacity planning and management, 4) vendor planning and management and 5) application planning.

Business Strategic Planning

Luftman defined business strategic planning as "a business strategy that is enabled (and) driven by IT." It defined the enterprise demands of its IT function through the strategic plan period and the opportunity IT has in meeting these demands" (Luftman, 2004b, p.123). He found that to drive the business strategy, senior IT managers must collaborate with senior functional managers (i.e., marketing, finance and research and development) (Luftman, 2004b). The process is important in today's dynamic business environment to maintain competitive advantage (Luftman, 2004b, p.24). Strategic alignment is connecting the goals of the business to the overall business strategy. For IT, this would involve partnering with other departments in the organization to ensure that all projects are moving in the same direction, to benefit the mission. Determining business strategy involved identifying strengths, weaknesses, opportunities and threats (also called SWOT analysis) within the organization. This information is used to identify gaps in the business (taking into account the current state of the market and its competitors) to decide what strategy to pursue. Luftman stated this process is to "enable IT to manage, anticipate and assemble technologies and methodologies to assure a stable and continuously improving IT environment" (Luftman, 2004b, p. 133).

In the area of CDSS, researchers have noted that one often mismanaged aspect of CDSS is garnering physician acceptance as noted in Chapter 1. Physicians are generally reluctant to use (or not fully use) these systems due to excessive alerts (McGee, 2010; Singh et al., 2009;

Versel, 2009; Weingart, Simchowitz, Padolsky, Isaac, Seger, Massagli et al., 2009). This

problem, called "alert fatigue, results in physicians ignoring the warnings" (Weingart, et al.,

2009, p.1472). A study from the Debakey Veterans Affairs Medical Center in Houston (along

with other Houston-area hospitals) found during 2007-2008 that out of "1,196" alerts of

abnormal pathology found in imaging results, 18.1 percent were lacking timely follow-up at four

weeks (Singh et al., 2009). This study concluded that training physicians how to read and

respond to their messages could help. Versel, listed other ways exist to obtain physician support

including: 1) limiting the amount of alerts to those critical, 2) telling the full-time medical staff

they can join with the hospital's malpractice insurer if they agree to use the CDSS, 3)

encouraging physician involvement in decisions regarding the system, 4) initially implementing

a part of the system that is simple to stakeholders it functions and 5) ensuring the rule-based

information and data contained within the system are accurate and up-to-date (Versel, 2009). In

summary, the IT process of business strategy played an important role determining how the end

user perceives the efficiency of CDSS.

IT Processes Associated with Project Management

Much has been written on the role of project management in ensuring successful

technology implementation. Meredith & Mantel (2006) found that project management provides

an organization with powerful tools that improve its ability to plan, implement and control its

activities as well as the ways in which it utilizes its people and resources (Meredith & Mantel,

2006). Luftman (2004) stated that project management is complex and encompasses multiple IT

processes. Project scheduling defines the work to be completed in terms of deliverables,

schedule and budget (Luftman, 2004b; Schwalbe, 2007). Project scheduling is an important

process to ensure a project does not fall beyond scope. This protocol usually involves change

request forms which must be approved by management before making the changes to the project.

Project evaluating (also called project closing) is the process where a project is audited for

deliverables. This occurs at the end of a project and is important for determining if the original

deliverables that were requested were in fact delivered (Luftman, 2004b; Schwalbe, 2007).

Project planning defines how the tasks are to be done and what resources will be needed

to complete the project in terms of scope (what was promised to the customer) (Schwalbe, 2007).

When devising a project plan, a project manager takes into account scope, budget and schedule

(Schwalbe, 2007). Project controlling is to use the project plan to monitor the project progress

and make adjustments if necessary (Luftman, 2004b; Schwalbe, 2007). Projects are controlled

by implementing a protocol for dealing with any additions or changes made to the project as it

progresses (Luftman, 2004b; Schwalbe, 2007). For example, if a piece of software is built with

multiple functions that the customer did not require, it could exceed budget and also create

scheduling constraints, which is why this IT process is important. Project assignment (also

called project initiation), is the last project management IT process in this list. It defines which

business leaders will be involved to ensure the project is a success. These leaders may include

steering committees, executive management, managers, sponsors (or champions−project

motivators) and etc. (Luecke, 2009; Luftman, 2004b; Schwalbe, 2007).

An initial literature review showed that IT processes associated with project management

are frequently attributed to an unsatisfactory CDSS (Kaplan et al., 2009; Liebovitz 2009;

Silverstein, 2009). Therefore, it is expected that system inefficiencies may be improved with a

better project management strategy. "A 2007 study of 214 projects, in a variety of sectors that

included 18 healthcare projects, identified inadequate management as accounting for 65 percent

of the factors associated with project failure" (Kaplan & Harris-Salamore, 2009, p. 292). Part of

these management challenges were insufficient gathering of requirements for designing these

complex systems. "Clinical support systems come in many different forms, have myriad aims

and can be implemented in different ways" (Wears & Berg, 2005, p. 1261). Therefore, it is

likely that inappropriate solutions are usually built for the incorrect type of staff using them.

      Project management appears critical to CDSS and other health information technology

(HIT) implementations. Liebowitz, (2009) authored over a dozen articles to find out what

problems were occurring with computerized provider order entry (CPOE) and electronic medical

record (EMR) systems.. He found that errors could have been prevented using the project

controlling IT process. Liebowitz described the current state of the healthcare community as still

"technically and culturally primitive" using these systems which is why he believes "with

appropriate planning and leveraging lessons learned from other sites, it is likely that many

unintended adverse consequences can be avoided" (Liebovitz, 2009, p. 925). Libowitz provided

on-line resources such as frequently recommended Agency for Healthcare Research and Quality

(www.AHRQ.gov) to find best practices and toolkits for monitoring and controlling these

systems (Kaplan, 2009; Liebovitz, 2009, Silverstein, 2009). Project managers implementing

CDSS could use these references for the monitoring and evaluating risks in the project

controlling IT process. Further, these sources could be used in defining requirements during the

project planning IT process to ensure a project does not fall beyond scope. Therefore, this

problem could have been prevented by the use of two project management processes.

      In another study, the American Medical Informatics Association noted that implementing

HIT is difficult for many reasons including problems that can be solved by project management

such as user acceptance problems and difficulty of gathering requirements. Some of the

proposed solutions were: mitigating risks to users, providing time for training and familiarizing

end-users with the system; all being the duties of a project manager (Kaplan & Harris-Salamore, 2009).

As mentioned in Chapter 1, a study found that improving the human–computer interface (HCI) is the biggest challenge implementing CDSS. This activity can be improved through requirements gathering (Sittig et al., 2008, p. 391). Further, making sure CDSS is implemented properly with a controlled medical vocabulary (CMV) and well defined order sets can also be improved through better management in this area. As a result of studies and best practices, it seems fair to conclude that a large portion of CDSS projects that fail are due to problems associated with project management IT processes and thus improvement in this area will eliminate the "wild goose chases," as one blogger stated, that healthcare professionals must perform to find the information they require from the system (Silverstein, 2009, msg 1, para. 7).

Finally, the lack of a project manager may affect project success. As noted in Chapter 1 one of the reasons the vendor failed to deliver (in addition to the unreliable secondary vendor) a working system to Drexel University College of Medicine was because the project manager discontinued working for their company.

Capacity Planning and Management

A number of researchers have examined the conditions under which capacity planning and management can sustain technology success. Capacity planning and management is accomplished by monitoring IT resources while performing forecasting (Luftman, 2004b, p. 170).

Some evidence exists that capacity planning and management can affect the productivity of CDSS. In a study of 32 hospitals in Ohio, researchers from Riverside Methodist Hospital found that the average downtime was 31 percent for software malfunctions linked to clinical-

decision support systems and additionally, 57 percent of the downtime was due to system

upgrades (Hanuscak, Szeinbach, Seoane-Vazquez, Reichert & McCluskey, 2009). The study

concluded that backup systems and protocols are not enough to reduce system downtime related

errors.

Vendor Planning and Management

The vendor planning and management IT process is another critical process. Luftman

(2004) states that important activities of vendor management include: 1) measuring and

monitoring vendor performance, 2) monitoring service level agreements, 3) vendor development,

4) coordination of outsourced IT activities, 5) negotiating compromises with vendors/users and

6) administering vendor contracts (Luftman, 2004b).

If not performed thoroughly, poor vendor planning and management may lead to

inefficient CDSS. Revisiting the Drexel v. Allscripts case, the medical school filed suit against a

vendor because it was dissatisfied with its HIT implementation (Philadelphia Health &

Education Corporation d/b/a Drexel University College of Medicine v. Allscripts, LLC. and

Medicomp Systems Inc., No. 001994, March 16, 2007; Silverstein, 2009). However, managing

the vendor was not easy, in this case, because the key faulty software component was outsourced

by another vendor. The suit noted that Allscripts, employed Medicomp Systems to build a

component, called the E & M Coder, that outputs a code for billing purposes based on

practitioner input into the system of services rendered (i.e., hematologic/lymphatic system

review) (Philadelphia Health & Education Corporation d/b/a Drexel University College of

Medicine v. Allscripts, LLC. and Medicomp Systems Inc., No. 001994, March 16, 2007;

Silverstein, 2009). This coder works with another component, called the Charge module that

categorizes the inputted data so that the E & M Coder can, in turn, analyze the data and render

the code (developed by Allscripts). Drexel University complained that the system caused

"erroneous billings," was missing some of the service categories and exhibited "multiple" other

"defects" (others were not listed in this particular court document) (Philadelphia Health &

Education Corporation d/b/a Drexel University College of Medicine v. Allscripts, LLC. and

Medicomp Systems Inc., No. 001994, March 16, 2007). One explanation for the faulty

component is that the secondary vendor lacked industry knowledge and failed to attach the

standard billing table to the code. For example, the billing table that is required for health

organizations according to HIPAA regulation was (at the time) based on the "1995" and "1997

guidelines" provided by the "American Medical Association" (Philadelphia Health & Education

Corporation d/b/a Drexel University College of Medicine v. Allscripts, LLC. and Medicomp

Systems Inc., No. 001994, March 16, 2007; Silverstein, 2009, p. 7, endnote 2).

Application Planning

The fifth area where problems can arise is measuring the value of applications. Luftman

(2004) noted that many organizations do not have IT processes in place to determine which

projects to choose over another. Parameters for evaluating projects should include feasibility,

business needs and current market state (Luftman, 2004b, Tiwana, 2002). Prioritization of

software projects determines whether a business invests in competitive technology yet does not

go bankrupt adopting every new technology.

A critical concern in evaluating electronic health record application components today is

ensuring that the software adheres to the "meaningful use" criteria established in the American

Recovery and Reinvestment Act. The law is intended to ensure the delivery of high-grade

electronic healthcare services in return for stimulus funds allocated to providers (GE Healthcare,

n.d., Introduction section, para. 2). "In order to qualify as a 'meaningful user,' eligible

[healthcare] providers must demonstrate [the] use of a 'qualified EHR' in a 'meaningful

manner'" (GE Healthcare, n.d., Introduction section, para. 2). Halamka (2009) wrote that this

"definition will influence the types of products that will be implemented in clinician offices and

the types of standards used for healthcare exchange" (Halamka, 2009, Introduction section, para.

1). Since this legislation is relatively new, it will likely take a few years before noteworthy

evidence emerges describing how this criteria affected the decisions regarding HIT application

planning.

Conclusion

This chapter explained why business-IT alignment is a fundamentally critical concept in

taking full advantage of IT, in terms of the strategic business planning processes it provides, the

value it provides in project and vendor management, as well as the control it provides in capacity

and investment planning among stakeholders. Parallels were drawn between these IT processes

and possible problem areas found with inefficient CDSS and HIT. All of these themes will be

expanded in subsequent chapters.

The next chapter details the methodology used to test the hypothesis determining whether

processes associated with project management are critical to implementation of CDSS.

Chapter 3 – Methodology

As the literature review in Chapter 2 showed, business-IT alignment considerations determine whether an IT implementation is a success or not. These considerations seem to rank over and above that of the functionality of any particular technology or service. To investigate this linkage, this chapter explains the two remaining phases of the research methodology used: survey generation and on-site interviews. This researcher focused on clinical decision support system (CDSS) projects.

Research Questions

While the first phase of the research reviewed academic literature, the second phase involved developing a survey based on five selected criteria as defined by Luftman's top business-IT alignment criteria. The survey consisted of the following questions:

- What vendor aspects made a difference in terms of clinical decision support efficiency for different CDSS projects?

- What system capacity aspects made a difference in terms of clinical decision support efficiency?

- What project management aspects made a difference in terms of clinical decision support efficiency?

- What business strategy aspects made a difference in terms of clinical decision support efficiency?

- What application planning aspects made a difference in terms of clinical decision support efficiency?

- Which IT process do you think is critical to clinical decision support system efficiency?

- What business need did the projects fulfill?

The survey, found in Appendix A, was designed to ascertain the respondent's attitudes on what criteria Luftman deemed critical in business-IT alignment. Therefore, the structure of the survey mirrored IT processes mentioned in Luftman's text. Questions focused on five IT planning categories: 1) vendor planning and management, 2) capacity planning and management, 3) IT processes associated with project management, 4) business strategic planning and 5) application planning. Participants were asked to recall one system they considered efficient (called project A) and one that was not (Project B). They were also asked to choose cases (if possible) that were similar in scale, occurred within the last decade and were installed at their current institution.

On-site Interviews

In phase three, on-site interviews were conducted with one administrator, director or department manager from four hospitals in the Denver area. The interviews were conducted during a two week period in April, 2010. Participants were recruited directly via phone or e-mail. This contact information was located using the Internet. This researcher's background, consisting of 11 years employed as a radiological research assistant, facilitated communication with these professionals. Typical job duties of the participants consisted of some or all of the following: manage IT, attend committee meetings, review specifications, work with vendors, review service level agreements (SLAs), conduct user acceptance, select technology projects and infrastructure, plan budgets, partner with other businesses and contribute to the leadership of their organization.

It was this researcher's original intent to send out a web survey to end-users and IT managers. This idea was discontinued to avoid professional risks to healthcare employees associated with rating their CDSS. The sample of participants was restricted to executives

responsible for IT and/or the medical IT of an organization. This was done for two reasons: 1) to ensure the participants possessed abundant expertise concerning CDSS (a topic most IT professionals are not familiar with) and 2) contact information and evidence that healthcare professionals are involved with CDSS projects usually consists of executives. However, choice limited the sample size as the availability of professionals of this caliber is limited.

Each participant was asked to choose which aspect made the biggest difference in contributing to an efficient (Project A) versus an inefficient (Project B) CDSS. Participants were also encouraged to explain their answers. They were provided equal time to discuss each presented IT process. The time participants spent on each process was measured to verify their answers. At the end of the interview, they were also asked to choose which of the selected five IT planning categories they believed to be critical in CDSS success. Finally, these individuals were asked what business needs Project A and B fulfilled.

Interviewees were provided a copy of the transcript and their survey answers. They were allowed one and a half weeks to verify the accuracy of these documents.

One qualified individual from four different healthcare organizations agreed to participate, out of the seven individuals (of five organizations) that were solicited. The demographics and data from the sample are as follows. Usually, the size of a healthcare organization is determined by bed count. The organizational size of the sample on average was a 315.75 bed count. In addition, 75 percent of the sample fell within the category of "general medical and surgical hospitals." Both demographics were verified by referring to the U.S. News & World Report at the time of the interviews. All CDSS example projects that each participant focused on for the interview occurred during last ten years. It is not useful to compare (or report)

statistics of the duration and cost of these projects as (unfortunately) these parameters varied

considerably.

Consent forms were provided for all participants. These indicated that they could choose

not to participate or withdrawal at anytime. The form guaranteed anonymity of the name of

participant and their respective answers. Participants were also told (not included in the consent

form) that their professional title, name of their institution and the names of any projects or

vendors they mentioned during the interview would be kept confidential. Additionally, the

consent form included the following: a description of the study, a description of what is

expected from the participants, a time line for participation, possible risks to the participant,

contact information for the researcher, contact information for the Regis School of Computer and

Information Sciences and a section to sign and date the form indicating willingness to

participate. Study findings were shared with the participants (also not mentioned in the consent

form).

The data described focused on the events of both past and present CDSS projects.

Participants were asked to select a project that met (or is meeting) its goals (in terms of

efficiency) and one that did not. Therefore, the data were arranged and sorted by the following

categories: 1) the IT planning process (i.e., project management, business strategic planning) that

determined the success of each project, 2) the aspect of each IT process (i.e., the project

manager's communication skills) that significantly affected success, 3) reasons for why the

participant selected their answers, 4) open-ended comments regarding best practices and

common problems associated with their example projects, 5) what business need each example

fulfilled and 6) a log of the duration participants discussed IT processes. Data was primarily

analyzed by sorting categorically to find the mode. The duration log was calculated statistically

for mean, variance and standard deviation. Omitted from the duration log was when the participant was not speaking or when they were discussing an unrelated topic. All statistics were calculated using Microsoft Office Excel 2007. Finally, a conclusion was formulated based on the data in regards to the hypothesis.

Conclusion

This chapter explained the two-phase methodology used to survey selected business-IT alignment criteria for CDSS projects. The on-site interviews with administrators from four hospitals inquired into five process areas: business strategic planning, IT processes associated with project management, capacity planning and management, vendor planning and management and application planning.

The next chapter covers the results of the survey and other information ascertained during the interviews with IT executives performed to find out what are the critical IT processes when implementing a CDSS.

Chapter 4 – Project Analysis and Results

The results of the survey show that aligning technology with business strategy is an important condition for successful clinical decision support systems (CDSS) planning and implementation. Project management is also a necessary prerequisite for success. This chapter presents in more detail the magnitude and the significance of the correlation between these and other study variables.

Meeting Business Needs

Healthcare organizations seeking to implement clinical decision support systems should generally align their investment decisions with the needs of the business. Table 1 summarizes the business needs of selected projects. Most systems involved the category of "systems for drug dosing and prescribing." This answer was expected as CDSS used for drug dosing and prescribing computerized provider order entry (CPOE) are common in many hospitals. This finding was supported by literature focusing the efficiency of these systems (Garg et al., 2005; Hanuscak et al., 2009; Koppel et al., 2005; Liebovitz, 2009).

Table 1: Driving CDSS

Business Needs for Project A

	Systems for diagnosis	Reminder systems for prevention	Systems for disease management	Systems for drug dosing and prescribing	Financial and Logistics Systems
Participant A		X			
Participant B	X	X	X	X	
Participant C				X	
Participant D	X			X	

Business Needs for Project B

	Systems for diagnosis	Reminder systems for prevention	Systems for disease management	Systems for drug dosing and prescribing	Financial and Logistics Systems
Participant A				X	
Participant B	X	X	X	X	
Participant C					X
Participant D			X		

Vendor Planning and Management

As noted in Chapter 2, technology success depends upon vendor planning and management. Figure 1 shows that the majority of participants−50 percent−found that the significant aspect to make or break the project was "the vendor's ability to deliver products and services that were promised." More specifically, the collected vendor planning and management data indicated three things in terms of CDSS efficiency: 1) the vendor's ability to deliver products and services that were promised was critical, 2) partnership and communication with vendors was essential, and 3) this information technology (IT) process was talked about (in terms of time) second to least.

IT leaders selected "the vendor's ability to deliver" for multiple reasons. One participant said it was successful because it was developed internally and another said it was less successful for the same reason. One participant selected this answer because their vendor almost failed to deliver however, the project saved due to collaboration between their IT department and the vendor.

Figure 1: Vendor aspects found critical by hospital IT executives to successful and less effective decision support system projects.

One person believed projects are delivered successfully if "the team members *take ownership* in the planning of the system." Luftman, and also the participants referred to this as "*partnership*" with business owners and stakeholders. Seventy-five percent of participants stated partnership with vendors was an important part of vendor planning and management. Another comment was that vendor management was important because hospitals, for the most part, no longer develop their systems internally. But a critical element seemed to be that without good communications, vendor partnerships can be at risk. As one participant pointed out it is not easy to have lunch with busy out-of-state vendor serving 100 customers. Another participant reinforced this point; stressing repeatedly that communication with vendors (and also other stakeholders) was *essential* to promote ownership in a project.

During the interviews, the researcher logged the time participants discussed IT processes. It was found that, on average, participants spent 14 percent of the interview discussing vendor planning and management, see Figure 2. The mean or average time a single participant spent on any one topic was 4.6 minutes, resulting in a standard deviation of 3.7 and a variance of 13.7. This figure indicated that this process is second to the last in terms of importance ahead of application planning. However, the wide variance and the fact that one participant does not usually work with vendors certainly affected the reliability of this measure.

Duration Participants Discussed IT Processes: (n = 4, $\bar{x}$ = 4.6, s = 3.7, s^2 = 13.7)

	Project Management	Application Planning	Vendor Planning	Capacity Planning	Business Strategic Planning
Participant A	13.9	8.5	8.2	2.5	9.3
Participant B	5.2	2.6	1.8	2.5	6.2
Participant C	10.3	4.9	0.2	1.1	1.8
Participant D	2.6	2.0	2.9	1.0	4.2

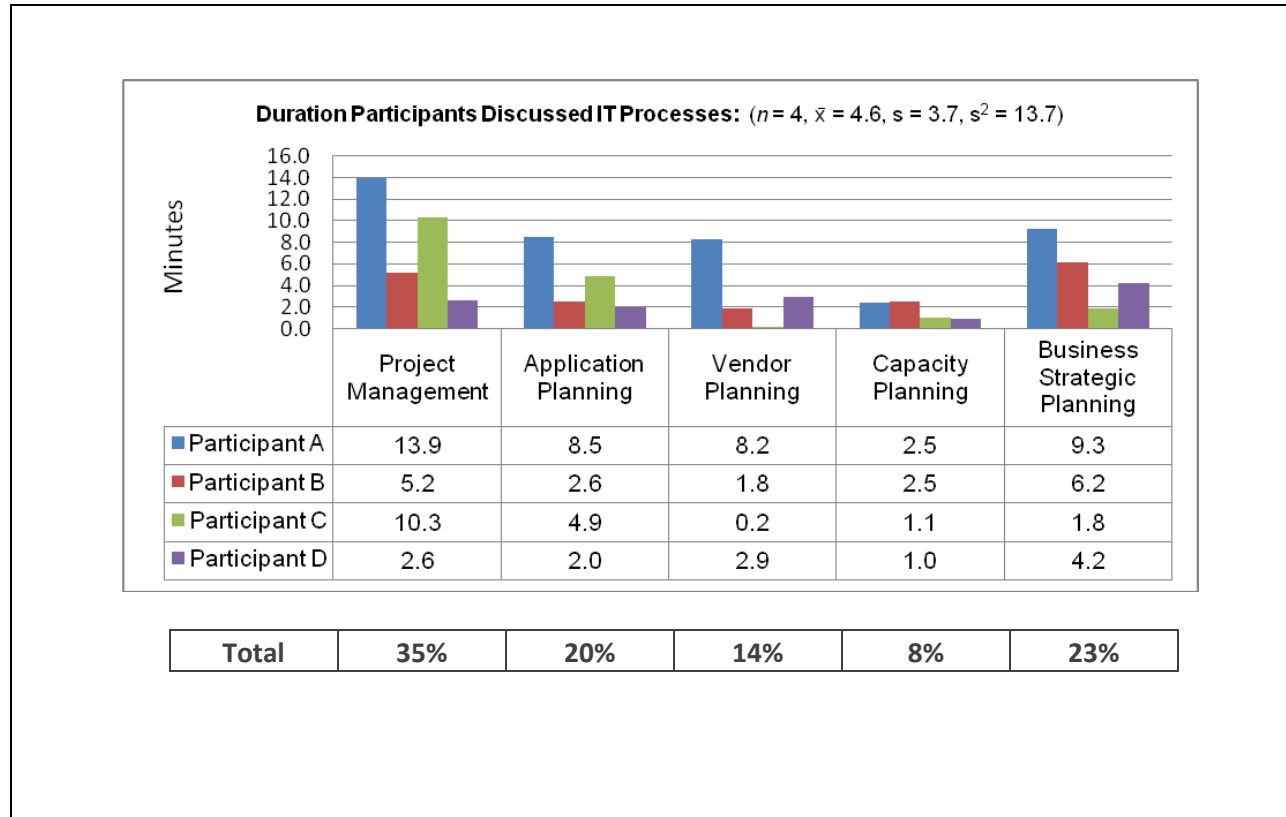| Total	35%	20%	14%	8%	23%

Figure 2: Duration hospital IT executives discussed critical IT processes of decision support system projects.

Capacity Planning and Management

　　　Capacity planning and management is critical to technology acceptance. This is especially true with CDSS as these systems access vast quantities of stored data. Without capacity planning and management, systems could run out of critical server resources, increase the time taken amending performance issues and result in an absence of trending data for planning. Figure 3 presents aspects of capacity planning critical to the success in implementing systems that can handle large quantities of data. To interpret survey results, most participants (100 percent for Project A and 75 percent for Project B) found critical "an end result that satisfied requirements." Two reasons can be identified. First, if requirements were satisfied, the projects continued to be funded. Second, satisfying requirements meant that the goal was met, which meant other capacity aspects were fulfilled such as increased system availability and a longer time before the system required an upgrade. Fifty percent of participants said that because requirements were not fulfilled, the projects were not successful during the system rollout phase. Participants said that lack of requirements fulfillment led to cancelled projects and non-functional software.

　　　Additional comments made by participants regarding capacity planning and management were minimal, placing less importance on this category. One comment, that 50 percent of participants shared, was that system capacity is not critical to senior management−unless the system goes down. In a similar comment from another participant, capacity management was not deemed to be the responsibility of the IT manager, but for IT staff; implying that IT leaders do not normally heed activities related to capacity. This is because executives expect available space of these systems to be unlimited, similar to the continual Internet connectivity, which does not require monitoring or decision-making on their part. One participant summed it up best

saying, "if we run out of space, we assume it's taken care of, but it's not [on] the top of my radar.

I have some storage engineers—that's all they do."

Figure 3: Capacity aspects found critical by hospital IT executives to successful and less effective decision support system projects.

As shown in Figure 2, the topic of capacity planning and management was discussed only eight percent of the time; accounting for it to be the least talked about IT processes.

IT Processes Associated with Project Management

Project management is always a key factor to a major IT initiative such as CDSS because the discipline aims for projects delivered on time, on budget and meeting quality requirements. However, as shown in Figure 4, a number of factors influence project management. Projects A and B answers consisted of varied project manager attributes including controlling the project scope, communication skills, scheduling ability and effective change management policies. Project B; for all a participants fell short of its goals due to scope creep resulting in incompletion of projects incomplete in terms of requirements and/or enhancements. Three Projects A were deemed successful because the project manager stayed focused, was flexible and was able to fit needed requirements into the schedule on time attracting additional funding. However, the project manager that satisfied requirements was able to do so because they were the developer in this small project. One participant said that the project manager's ability to communicate determined whether a project was successful or unsuccessful.

Project A: *n* = 4

- The project manager's scheduling ability to deliver the project on time and as promised.

- The project manager's communication skills.

- The effectiveness of the project manager's change management policies.

- The project manager's ability to accurately measure projects regularly and make adjustments to the project scope accordingly.

25%   25%
25%   25%

Project B: *n* = 4

- The effectiveness of the project manager's change management policies.

- The project manager's communication skills.

- The project manager's ability to accurately measure projects regularly and make adjustments to the project scope accordingly.
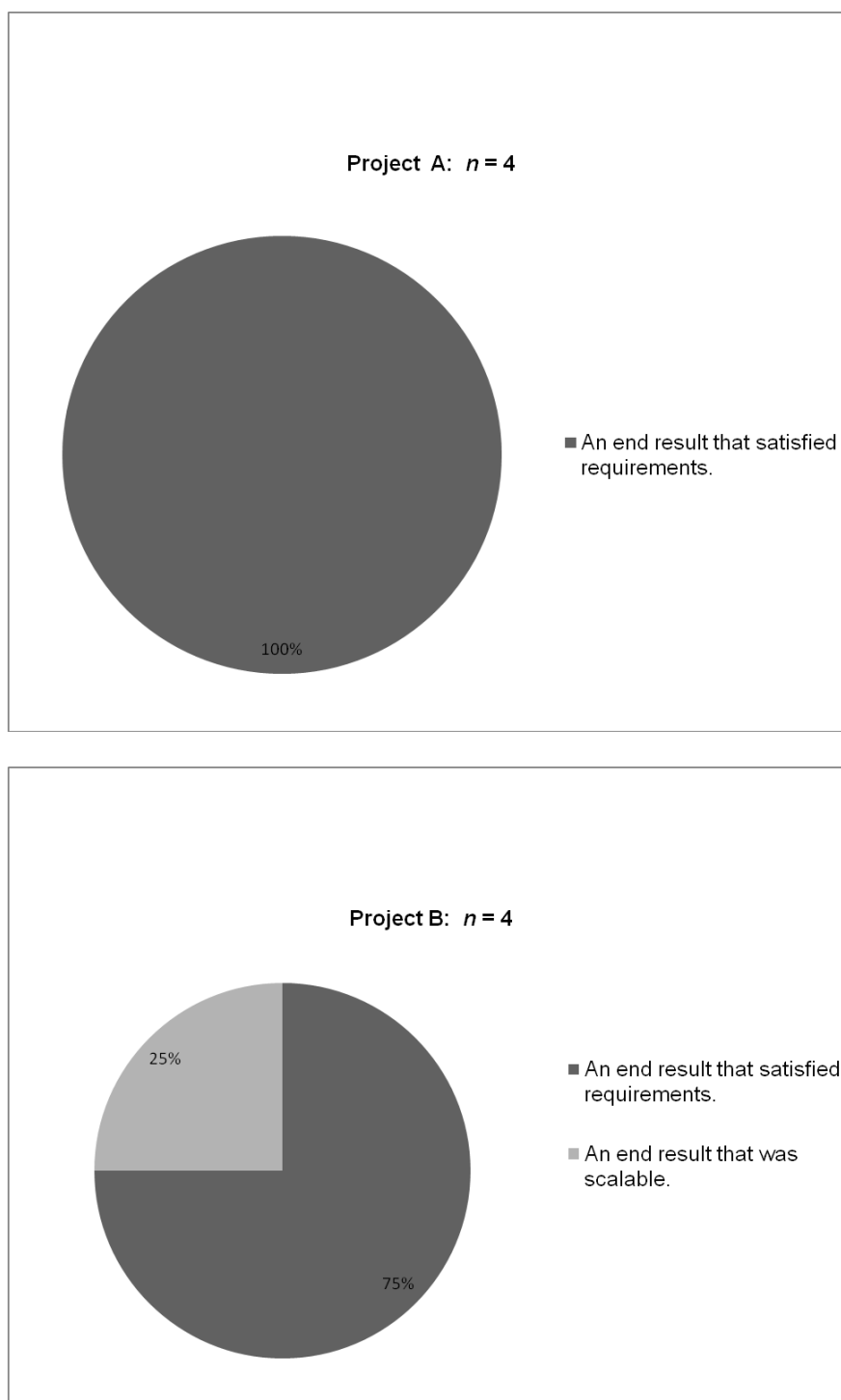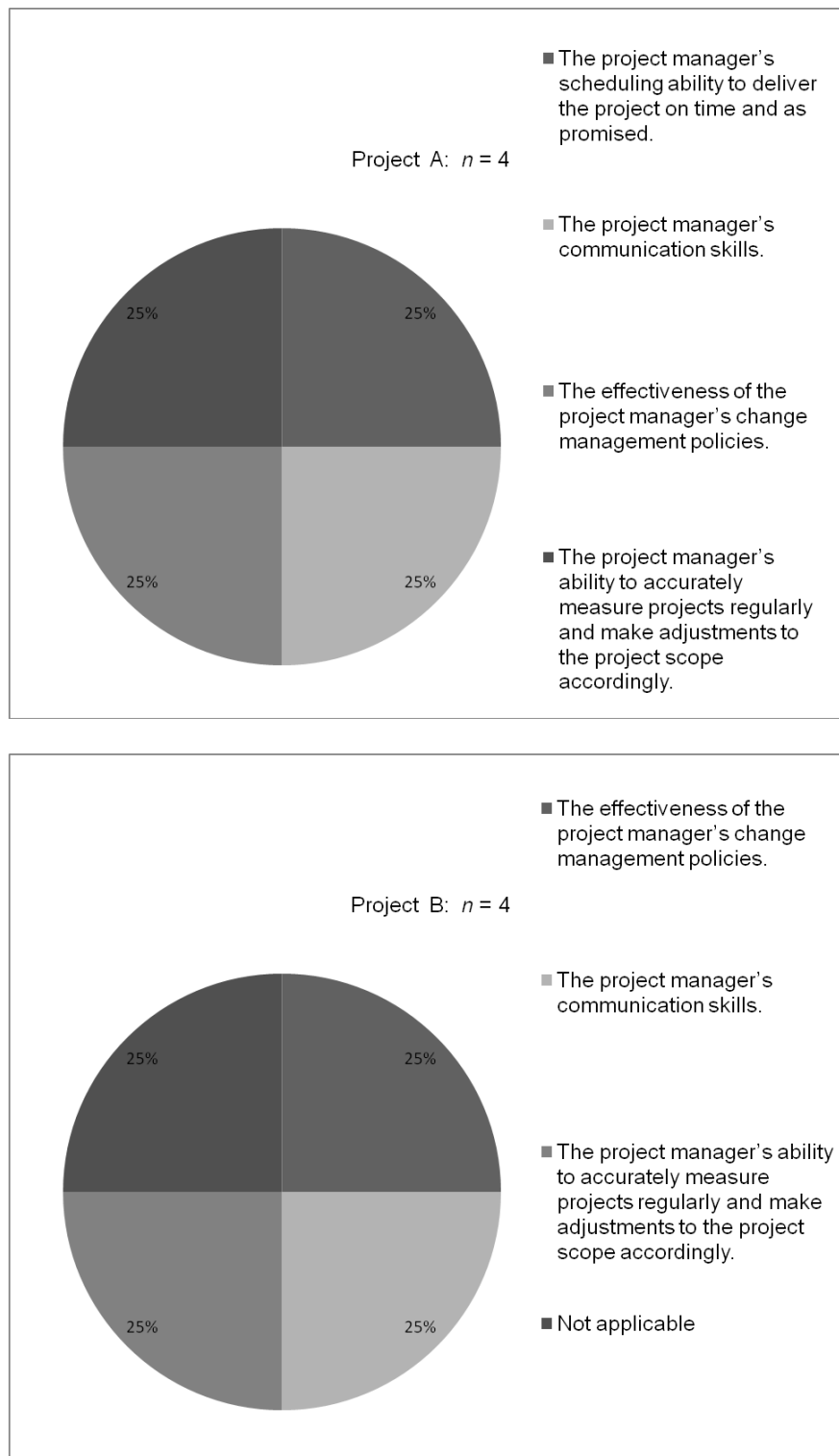
- Not applicable

25%   25%
25%   25%

Figure 4: Project management aspects found critical by hospital IT executives to successful and less effective decision support system projects.

A significant amount of comments centered on the value of project management in dealing with change. According to one participant and the IT community in general, change is inevitable and is especially true as technology and regulations change. Another participant stated that physician culture is usually resistant to change and therefore it is a good practice for project managers and senior management to inform and train physicians prior to CDSS installations.

The importance of communications was also stressed, although documentation was not considered important. Seventy-five percent of the participants stated that executives, upper management and project managers should regularly communicate with project stakeholders. One participant stated that project managers *must* have people skills before technical skills to be able to communicate with stakeholders. On the topic of documentation, 50 percent of participants agreed with the consensus of the survey, being that documentation was the least important aspect. One participant reinforced this finding, pointing out that writing documentation could result in failure to communicate with stakeholders if a project manager spends too much time secluded in an office typing up documents instead of speaking with stakeholders. This statement contrasted with one participant that the said documentation is important to gain project support. It also countered the fact that 75 percent of participants mentioned some form of adherence to the document-driven Project Management Body of Knowledge (PMBOK) standard guide for certified project managers.

As Figure 2 showed, project management was the most widely discussed of all the IT processes (35 percent). While the average time participants spent talking about any of the five presented processes was 4.6 minutes, participants A and C spent a considerable time talking about project management: 13.9 and 10.3 minutes (respectively)!

Business Strategic Planning

Figure 5 provides evidence that a failure to plan is planning for failure. Participants spent almost as long talking about business strategy as project management. This counters the unanimous answer stating that business strategic planning was the most important IT process for question six in the survey. Aside from this contradiction, the critical aspects found for business strategy were the level of commitment from upper management and also the amount of motivation from project champions. Actions of executives and champions seemed ultimately to affect the result of CDSS projects. Comments for this category consisted of stakeholders taking ownership in the planning of a project, leveraging technology to work on limited budgets, solving limited staff problems by adding a few qualified professionals and strategic alignment.

Motivated executives and champions were likely so because they invested a lot of time and revenue in planning and implementing projects. The survey found that 75 percent of participants stated that "the level of commitment from upper management and also the amount of motivation from the project champions" was the determining factor in both successful and less successful CDSS projects. Two people felt that a champion led employees to believe the system was important so employees worked hard to implement it. Another said the lack of support resulted in a cancelled project. One said that upper management noticed users were dissatisfied with the system and withdrew their support. Finally, it was said that because leaders saw that a project fulfilled requirements and was on time, they continued supporting it.

Project A: $n = 4$

25%

■ The level of commitment from upper management and also the amount of motivation from the champions of the project.

■ Staffing the IT department with knowledgeable team members.

75%

Project B: $n = 4$

■ The level of commitment from upper management and also the amount of motivation from the champions of the project.

25%

■ Selecting projects with minimal risks or mitigating the risk of ambitious projects.
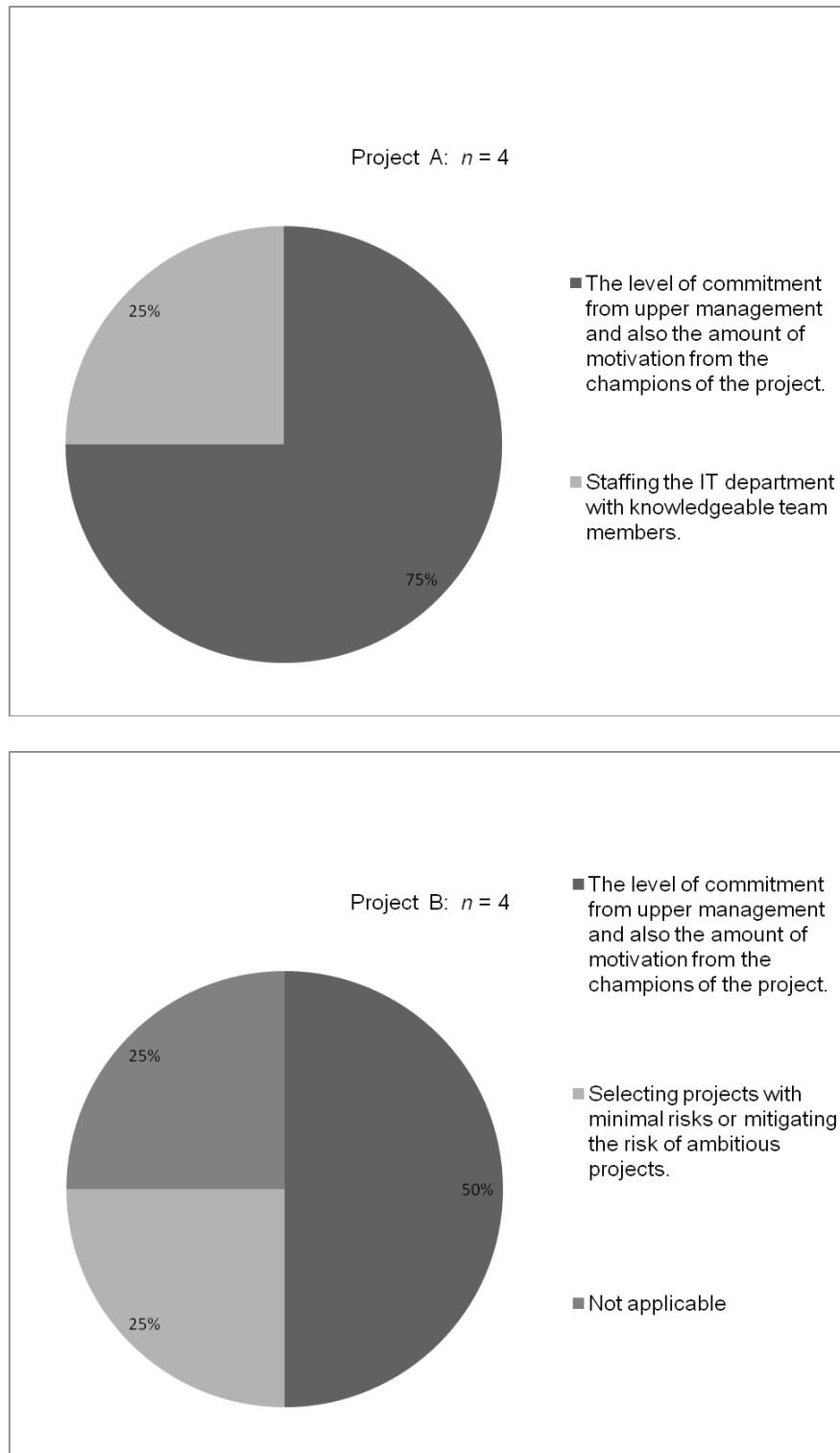
50%

25%

■ Not applicable

Figure 5: Business strategy aspects found critical to IT hospital executives to successful and less effective decision support system projects.

Seventy-five percent of participants echoed a comment that the success of projects depended upon team members "taking ownership" in the planning of a system. The same percent said that less funding in healthcare meant IT leaders were often asked to "work smarter." One participant pointed out that staff shortages can affects CDSS efficiency, but this can be remedied by having a few knowledgeable employees. Additionally, 75 percent of participants said that efficient CDSS do not matter if these applications are unnecessary to the business. Similar to this comment, it was said that the IT business plan should mirror, not differ, from the overall business plan.

Out of the time participants spent speaking about the five presented IT processes, participants spent 23 percent on business strategy; falling behind project management.

Application Planning

Figure 6 presents the results about the importance of application planning for successful CDSS. The data showed that 75 percent participants found that application planning should be patient-focused and should positively impact return on investment (ROI). One participant mentioned that often CDSS are perceived as inefficient because the project was not a priority, thus not fulfilling the company mission. Another participant explained that "strategic alignment helped the business achieve its primary needs whereas doing unnecessary projects wasted resources without showing improvement for the business." According to 75 percent of the participants, the industry's overall mission, of improving patient health, was usually difficult to measure, yet ROI is important for acceptance and continuation of projects.

Some participants determined the "foresight in decision making when it comes to choosing application projects that will serve the end users it was designed for" as critical to the application planning process. In fact, one person said that a project was wrongly pursued

because it was too large in scope and thus was cancelled (after considerable time and money was

spent). Another participant noted that an application did not meet needs because the system

components were designed by the vendor and to be sold as a package, yet it was purchased in

modules due to budget constraints. This ultimately led to numerous bugs in the software ;

illustrating the challenges some IT leaders have planning and building applications funded by

grants which, in this case, have to prove their system can stand alone after one year if they wish

to receive additional funding in the next.

Applications that make a difference in the company mission led to participant comments

describing the HIT environment today, which aims to achieve patient-focused systems. Several

noted that decision support systems played a critical role in disease prevention. The amount of

time participants discussed application planning ranked ahead of vendor planning and

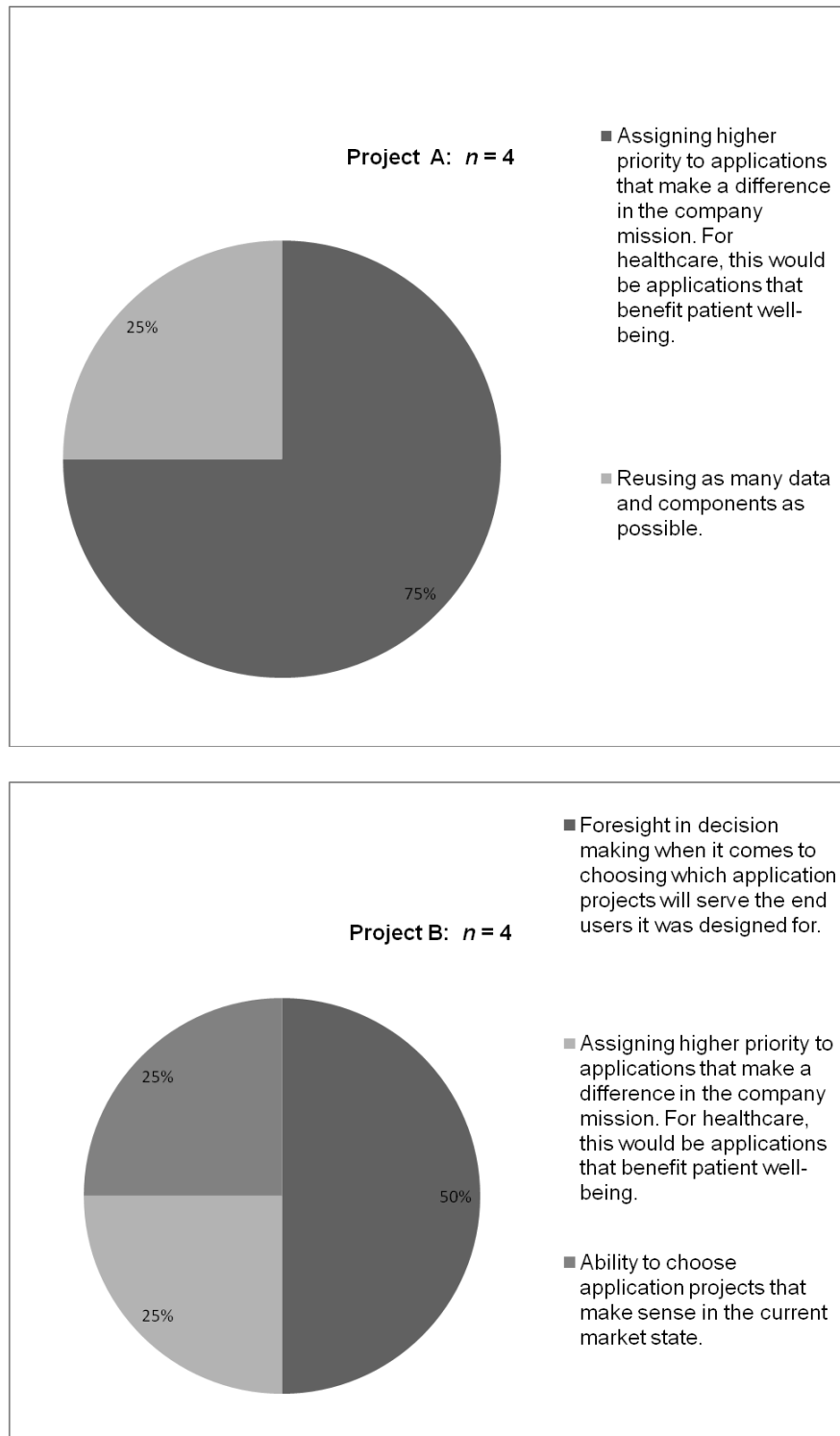management, but behind business strategic planning.

Figure 6: Application aspects found critical by hospital IT executives to successful and less effective decision support system projects.

Conclusion

The survey results showed that IT processes associated with business strategy topped the

list of the five selected processes, followed by project management, application planning, vendor

planning and management and capacity planning and management. Contrary to the survey

results, the interview results found project management to be critical. Business strategy is

important because in both processes, success was achieved when stakeholders took ownership as

partners of the system and their company's business. However, no one wants to take ownership

of a system that is not supported by upper management. That is why leadership is an important

part of projects. All participants agreed that good leaders are ones that can effectively

communicate. The findings also proved that no one wants to work on a project that is

unnecessary. That is why the successful CDSS projects had an increase in stakeholder

involvement when applications were built that benefitted the organization mission. Most

participants pointed out that in healthcare, these are the applications that benefit patient health

while at the same time generate a good ROI. Choosing HIT projects that meet the mission while

showing profit means the company has achieved strategic alignment (an enabler to the success of

the company). Leveraging technology such as CDSS has the potential to do both. It allows

companies to leverage technology and thus "work smarter" on a limited budget. In the next

chapter, key points from this document will be summarized to support the final conclusion.

Chapter 5 – Conclusions

Throughout this research, the connection between clinical decision support systems (CDSS) and desired information technology (IT) processes was investigated. The underlying hypothesis stated that project management was the key IT process explaining why some healthcare institutions struggle while others succeed with CDSS. The findings were contradictory in terms of the hypothesis. This is because participants unanimously selected business strategy as the critical IT process in the survey but spent a longer duration talking about the project management during the interview.

Limitations and Challenges

In developing this research, a variety of procedures were used. Four healthcare organizations, based in the Denver area with participants that had decades of experience in health information technology (HIT) decision making process, were surveyed. All participants were currently or previously involved in CDSS projects. Therefore, it was likely these participants understood how IT processes relate to CDSS efficiency.

It was anticipated that medical professionals would be unwilling to participate due to: 1) tight professional schedules, 2) organization loyalty, 3) vendor contract limitations and 4) Health Insurance Portability and Accountability Act (HIPAA) regulations. On the contrary, persons interviewed were receptive to being surveyed.

Still, there were limits in the use and interpretation of the findings. Only four institutions were surveyed. This limit was largely due to the time restrictions imposed on the project. In addition, their time allotted for onsite interviews was limited to approximately one hour per

individual. Furthermore, categorizing the IT processes into groups (that were related to a CDSS implementation) was an objective activity that involved a degree of error. This was due to the large number of IT activities documented in the literature; making it unattainable for the researcher to observe all processes. Choice of a sample was limited for multiple reasons. Therefore, it was a selection of convenience and not representative of the average US hospital, CDSS project, HIT manager or the healthcare community as a whole. All attempts were made to locate a representative sample. However, it was unattainable due to the specialized nature of healthcare, the limited amount of participants and hospitals available fitting the thesis criteria, the limited amount of CDSS projects and finally, time constraints of participants and the researcher.

The hypothesis was that project management was the key IT process explaining why some healthcare institutions struggle while others succeed with CDSS. It was found that the interview results supported the hypothesis, while the survey negated it, finding the process of business strategy (as opposed to project management) to be critical. Interviewees stressed the importance of aligning technology to the mission of improved patient health while achieving a return on investment (ROI). Nevertheless, there appear to be several reasons for believing that project management is still a crucial IT process. First, participants spent more time talking about it than any of the other IT processes. Second, all participants stressed the importance of communication, on-time and within budget delivery in a CDSS project (three traits of effective project management).

The literature review supported the importance of project management, especially in areas of requirements definition to ensure user acceptance.

The common problem found in the literature attributed to CDSS efficiency was user acceptance. Cases of physicians ignoring alerts, manually overriding software recommendations, refusing to use the systems and in some cases, protesting their existence within their organization lead to this idea (Ball & Douglas, 2005; Ball et al., 2008; Blumenthal & Glaser, 2007; Garg et al., 2005; Philadelphia Health & Education Corporation d/b/a Drexel University College of Medicine v. Allscripts, LLC. and Medicomp Systems Inc., No. 001994, March 16, 2007; Versel, 2009). In Drexel v. Allscripts, "doctors overrode" the software's "recommendations" because they were aware the software was not functioning properly (Philadelphia Health & Education Corporation d/b/a Drexel University College of Medicine v. Allscripts, LLC. and Medicomp Systems Inc., No. 001994, March 16, 2007, p. 13, section 49). In addition users rejected one-size-fits-all systems. It is difficult to obtain requirements from the varied professionals using the technology (Ball et al., 2008; Kaplan & Harris-Salamore, 2009; Wears & Berg, 2005). User acceptance problems can be remedied by mitigating risks to users, providing time for training and familiarizing end-users with the system.

Additionally, requirements gathering can be facilitated by stakeholder involvement. A participant stressed that the ability of the project manager to communicate is essential. That is because it is the project manager's duty to be the liaison between the project team and the user of CDSS, (i.e., the physician, nurse). The project manager must work with users and project teams to rollout these systems to the end-user environment. The project manager is also responsible for outlining responsibilities for all the stakeholders (i.e., end-users, managers, project team and vendors) (Schwalbe, 2007). They oversee and direct (with the program manager) the strategic IT plan and the development of business requirements. They also define the deliverables of the project, see if the project is feasible, develop protocols for dealing with changes to the project

scope and create protocols for acceptance of the final product (Schwalbe, 2007). The project

manager is a central part of projects with multiple duties and therefore, it is not surprising that

participants made numerous and varied comments pertaining to this area.

This research should be considered an early attempt to identify IT processes that impact

the outcome of CDSS. It encourages other researchers to broaden the sample size and test the

validity between subjective and objective measures in the CDSS development lifecycle. The

literature could also benefit from studies in other sectors of the healthcare industry and using

other methodologies. The findings of this study support the importance of project management,

but further research could provide added completion and useful details to this account.

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Appendix A: Structured Interview Questions

Please answer the questions for this interview based on clinical decision support system implementation and maintenance projects you were associated with. If possible, please use projects that were: 1) similar in scale, 2) within the last decade and 3) at your current institution. Please pick one system you considered efficient (we will call this project A) and one that was not (project B).

1. What vendor aspects made a difference in terms of clinical decision support efficiency for projects A and B?

    a) The vendor's ability to deliver products and services that were promised.

    b) The vendor's ability to address changes that arose in the project.

    c) The amount of relevant knowledge the vendor possessed.

    d) The vendor receiving a workload amount that they could easily handle.

    e) Incentives encouraging the vendors to fulfill their obligations.

2. What system capacity aspects made a difference in terms of clinical decision support efficiency for projects A and B?

    a) An end result that was scalable.

    b) An end result that satisfied requirements.

    c) Your IT department's ability to address changes that arose in the project.

    d) Overall system availability.

    e) How long the system lasted before requiring an upgrade.

3. What project management aspects made a difference in terms of clinical decision support efficiency for projects A and B?

    a) The effectiveness of the project manager's change management policies.

    b) The project manager's communication skills.

    c) How thorough the project manager documented the project.

d) The project manager's ability to accurately measure projects regularly and make adjustments to the project scope accordingly.

e) The project manager's scheduling ability to deliver the project on time and as promised.

4. What business strategy aspects made a difference in terms of clinical decision support efficiency for projects A and B?

a) Selecting projects with minimal risks or mitigating the risk of ambitious projects.

b) Selecting projects that do not compromise all mission critical systems at once.

c) Staffing the IT department with knowledgeable team members.

d) Ensuring IT cuts across all silos of the organization and works with all departments.

e) The level of commitment from upper management and also the amount of motivation from the champions of the project.

5. What application planning aspects made a difference in terms of clinical decision support efficiency for projects A and B?

a) Assigning higher priority to applications that make a difference in the company mission. For healthcare, this would be applications that benefit patient well-being.

b) Foresight in decision making when it comes to choosing which application projects will serve the end users it was designed for.

c) Reusing as many data and components as possible.

d) Ability to choose the application projects that will show tangible business benefit or return on investment for the department(s) that generated the project revenue.

e) Ability to choose application projects that make sense in the current market state.

6. Which IT process do you think is critical to clinical decision support system efficiency?

a) Vendor planning and management

b) Capacity planning and management

    c) IT processes associated with project management

    d) Business strategic planning

    e) Application planning

7. What business need did projects A and B fulfill?

    a) Systems for diagnosis

    b) Reminder systems for prevention

    c) Systems for disease management

    d) Systems for drug dosing and prescribing