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Business Intelligence and Learning, Drivers of Quality and Competitive Performance

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BUSINESS INTELLIGENCE AND LEARNING, DRIVERS OF QUALITY AND COMPETITIVE PERFORMANCE

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ABSTRACT

Purpose: As healthcare organizations expand the scope of their operations with an eye towards cost reductions, quality improvements, sustainability, increased stakeholder satisfaction and increased performance, they are increasingly investing significant resources into information systems in general and Business Intelligence Systems (BIS) in particular to provide the necessary operational and decision support information. This paper seeks to model the relationships between BIS, learning, quality organization and competitive performance, as well as measure the influence BIS has on end-user perceptions of quality and competitive performance from a learning point of view.

Methods: Qualitative and quantitative methods including survey, interview, and case study instruments to measure the link between BIS, learning models of mental-model building and mental-model maintenance, quality organization, and competitive performance. Individual, organizational, system, information, and service characteristics are explored to measure the relationship between variables. Extending models from prior-literature, a proposed model is introduced to improve the explanatory power of the prior model, and extend theoretical, practical, and policy contributions within a healthcare setting.

Results: Results demonstrate a significant relationship between learning, quality and competitive performance when utilizing BIS. Information and system quality characteristics also influence the level of learning. The model increases the explanatory

power over the prior information support systems and learning models and adds important contributions to healthcare research and practice.

Contribution: Technology improvements and cost reductions have allowed BIS to be extended to the entire set of organizational stakeholders to provide information for various forms of decision making. Despite these improvements, there is still a significant organizational investment and risk to implement and maintain BIS. Expectations and funding for BIS in healthcare are based on the desire for improved quality and competitive performance across all levels of the organization. Previous information systems have not demonstrated a link between multiple forms of learning and competitive performance. In addition research does not directly address how BIS and learning impact healthcare quality or discuss BIS specific relationships specifically within a healthcare setting. BIS which expand the inherent information analysis capabilities and expands usage to all stakeholders demonstrates a link between both mental-model building, mental-model maintenance as a component of learning, quality organization and competitive performance. Through democratizing BIS, organizations can become sustainable through improved healthcare quality and competitive performance across all employee levels.

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DISSERTATION SUMMARY

Topic: Business Intelligence and Learning in Healthcare Quality and Competitive Performance

Research question: What is the relationship between Business Intelligence Systems (BIS), learning, quality, and competitive performance in healthcare?

Directional hypotheses:
H1: Individual Learning -> Organizational Learning
H2: Information Quality -> Organizational Learning
H3: System Quality -> Organizational Learning
H4: Service Quality -> Organizational Learning
H5: Organizational Learning -> Competitive Performance
H6: Organizational Learning -> Quality Organization
H7: Quality Organization -> Competitive Performance

Big Problem:
To combat rising healthcare quality and costs, organizations have made significant investments in BIS, however maintain ongoing implementation and usage risks. User expectations for BIS in healthcare not only include performance improvements as in other industries, but equal quality expectations.

What is Known:
In separate literature streams, information system characteristics have been shown to have a relationship with learning, and in turn with performance and quality.

Knowledge Gap:
Earlier research with information systems were unable to demonstrate a relationship between mental-model maintenance and competitive performance. Past research did not focus specifically on BIS for learning contribution or learning contribution on quality. Specifically the healthcare setting has not been explored, where learning leads to improvements in quality.

Design and Methods: This research seeks to measure how things are related. The general design follows both qualitative and quantitative approaches. Instruments for data collection include survey, interview, and case study.

Contribution:
Identifies relationships of BIS on learning, quality, and performance within a healthcare setting. Adds to theoretical knowledge through explanatory power and theory building. Adds to practitioner knowledge through priority determination, IT/business budgeting requirements, success estimation, quality, and performance improvements. Policy knowledge can be gained through healthcare information systems funding, focus of government programs, and overall quality focus of healthcare.

I. INTRODUCTION

1.1 Background

Organizations are increasingly widening their focus to all stakeholders. These stakeholders include executives, line level employees, partners, and individual customers. Sustainability is becoming an apparent theme throughout various industries, and refers to the balance between short and long term requirements, as well as the balance between the individual and their environment. Sustainability should be integrated into the business and as a part of performance management culture and program to improve individual learning. One key to learning is generating goals, and monitoring those goals through an information system, and creating action plans. When fully applied, this can become a competitive advantage for the organization through early identification of potential risks and opportunities. Organizations require full integration of diverse requirements in a manner that benefits all stakeholders during decision making processes. To address and support the needs of all stakeholders, organizations increasingly turn to advanced BIS in order to sustain and improve learning and associated quality and competitive performance [1, 2].

1.2 Problem Statement

Business Intelligence (BI) is a high adoption and high growth area, as users quickly value the capabilities and increasingly demand more BI capabilities. However, from a return on investment (ROI) standpoint, BI is similar to ERP and CRM, in that it has a poor risk/reward profile, as it regularly runs into cost overruns, due to scope creep and limitless requests for support from end-users [3]. Unlike operational systems which often have specific requirements and implementation completion timelines, BI environments are constantly evolving to meeting business and information requirements [4]. In order to effectively measure BI success, multiple constructs can be utilized, and several approaches should be chosen to identify success measures based on research objectives and investigation during development of the research model [5].

In response to stakeholder and organizational requirements of increased information accessibility, generated technology value, healthcare quality and cost improvements, BIS are implemented to provide data warehousing, performance management, reporting, and analysis capabilities to the organization in support of decision making and learning, in order to achieve sustained quality and competitive performance. Prior studies with alternative systems to BIS, were not able to demonstrate a link between multiple forms of learning and competitive performance. When discussing sustainability, the modern healthcare organization must be provided with the tools necessary to improve upon existing information and decision making capabilities.

This study addresses the relationship between BIS, quality and competitive performance when viewed through a learning perspective and empirically demonstrates that relationship through use of survey, interviews, and case study within the healthcare setting. This study also presents several key findings and best practices as identified through prior literature review and a formal case study, which extends and enhances prior literature and understanding of BI.

1.3 Significance

Due to recent economic downturn, organizations are increasing modifying various strategies and quality improvement initiatives to continue viability. Organizations have invested substantial resources and time into information systems, yet still have difficulty achieving quality improvements and competitive advantages [6]. While research has addressed general quality aspects within an industry [7], it does not directly address (1) how BIS information quality practices affect quality across the entire organization (2) what BIS factors lead to and sustain a quality organization and competitive performance. Additionally no known literature specifically addresses quality organizations and competitive performance effects of BIS information quality through learning. Further investments have been made within BIS for streamlined access and analysis of information for decisions, and is touted as the next step for companies to achieve competitive performance [6-8].

While many other industry sectors have seen budget reductions, the healthcare industry is seeing renewed interest in information technology spending due to recent government initiatives, with $19 billion earmarked for computerized systems to help to reduce costs and improve quality [9]. Despite this, computerization alone does not cause automatic increases in productivity, but rather is a critical component of organizational improvements [10]. Healthcare executives have noted that while federal programs and incentives for health IT are valuable, the key driver is quality, through improved health outcomes and organizational excellence. The value is justified through improving patient care, and providing a global patient view, through improved systems, interoperability, efficiencies, cost savings, and revenue growth [11]. Typically, major general purpose technologies require substantial resource commitments, and occur over time. BIS are increasingly addressing key areas of need within healthcare in a more timely manner such as errors, closed system architectures, data integration, partial standards, master data management, and competing vendors [12].

Although there is a small body of growing research on BIS, literature specifically addressing learning, quality, and competitive performance relationships of BIS is missing. Additionally, while a significant amount of effort and funding is occurring presently within the healthcare information technology sector, no known literature specifically addresses healthcare quality and competitive performance effects of BIS through learning. This study will demonstrate relationship significance of BIS on learning, quality and competitive performance improvements over prior methods, specifically within the healthcare industry.

To achieve a quality organization, healthcare entities are increasingly adopting BIS capabilities to assist with performance management and continuous improvement. A BIS process framework is presented for managing a quality organization and improving operational efficiencies, through presentation of a case study for achieving a quality organization as measured through stakeholder satisfaction. The BIS capabilities and processes allow for individual organization's to focus specifically on those areas which have the greatest impact on becoming a quality organization. Significant results are demonstrated following the proposed process framework, leading to improved organizational quality. As healthcare organizations seek to continually improve overall quality, BIS plays a critical role in providing streamlined access to summarized information utilized for decision making.

While there is a well-documented link between quality and customer, employee, and shareholder satisfaction in prior management literature, past studies have shown conflicting results in the directional relationships between customer, employee, and shareholder satisfaction. This is often attributed to the need for measurements over time and firm variability. Within the healthcare industry, organizations have not always had the appropriate healthcare information technology (HIT) to monitor, analyze, and improve all aspects of customer, employee, and shareholder satisfaction simultaneously, utilizing a formal process framework. In addition healthcare quality is often difficult to define and measure based on the various stakeholder requirements. There are often considerable variances between healthcare and non-healthcare industries, as well as variances within organizational sub-units, requiring a method for continuous monitoring and improvement that is tailored to the individual healthcare organization. A case study is employed, along with a descriptive process framework, to monitor, analyze, and plan for organizational quality management.

1.4 Research Support and Theoretical Foundations

Support for applying BIS to mental-model maintenance, mental-model building, quality, and competitive performance improvements occurs from the following areas: learning and knowledge theories, user base, utilized methods, healthcare information systems research, and current industry research. Healthcare represents a complex and knowledge-rich domain, requiring multiple learning theories to explain. Collaboration occurs regularly, with cognition formed by social and technical components. The environment requires efficient information gathering and decision making for patient care. Research such as technology-based decision support, web-based health care information, online learning environments, and collaboration tools have contributed to cognitive and learning sciences. Learning theories have evolved from looking at memorization to understanding, and have often influence organizational practices. Complementary theories have been developed to address a variety of learning scenarios from simple structured learning domains to complex unstructured learning domains. Learning in complex unstructured domains require a strong basis of knowledge and self-monitoring of practice, understanding beyond memorization, include multiple problem scenarios, prior experience, and regular assessment of learning [13].

Many systems do not provide the necessary capabilities that all users require such as adapting to rapidly changing environments, scalability, and real-time decision making. In order to make the required decisions, users must sift through increasing amounts of information, while maintaining production efficiency. Information processing theory, from cognitive physiology discusses limitations to the amount of information received, processed, and remembered. These cognitive concepts allow further support for research into learning [14-16]. Organizations have invested in information systems in order to increase information processing capabilities and drive performance. Today's technology savvy users increasingly require their own dashboards, analytics, and report generation through a web-based interface to aid in decision making [8, 14-18].

Nonaka (1994) discusses dynamic theory of organizational knowledge creation, which is created through tacit and explicit knowledge patterns. Organizational knowledge is an upward spiral from individuals, to groups, to organizations, and inter-organizations. BIS can assist with internalizing explicit knowledge is to increase the user's understanding of the knowledge or mental-model maintenance. Understanding includes the purpose or what the user wants to understand, system or process to be understood, and arguments about the design purpose. BIS can also assist with internalizing explicit and new knowledge, or helping a user to learn through mental-model building. Modification to an internal mental model can be one form of internalizing explicit knowledge. A user may modify their mental model based on discovery of relationships for example. Another mental model modification may be relative weighting of factors. Quality may also be dependent on the ability balance control and learning. Control is maintained through formal methods and elimination of variances. Learning is maintained through organizational learning and continuous improvement [19-22].

The historical user base for ESS was small, representing only top level employees due to cost or perceived need. With BIS, the user base is expanded to all or most stakeholders, significantly improving usage and user base over ESS. Mental models have been linked with performance and effectiveness of a team. These teams can demonstrate better planning, coordination, and effectiveness through a shared mental model. When organizational members share information or mental model similarity, task processes and outcomes, they understand perspectives, communicate easier, and coordinate more effectively, leading to improved performance. Decisions based on shared knowledge and understanding yields improved decision making quality [17, 18, 23, 24].

Knowledge-based theory of the firm posits knowledge as a strategic firm resource, and a source of sustained competitive advantage.   In the past, ESS decisions were typically made periodically regarding strategic items of importance and only within executive staff or only a small percentage of users, as they are expected to yield the most decision making ability. Their use was mandatory, and as a result is often dependent on the support of the executives or individual users. Today BIS not only supports strategic decision making, but additional capabilities are employed to support wider ranges of business functions such as operational process improvement, and use of BIS is now increasingly being used by various levels of the organization. These systems also focus on the capability to move between aggregated and detailed data, and use key performance indicators to track organizational items This has allowed line and operational level employees full access to information to make day-to-day decisions [17, 18, 25, 26].

Research has shown that increased quality services are relational to increased market share, profits, cost savings, and competitive performance. Quality is also often identified as a marketing and financial performance driver. Quality perceptions of patient have been found to account for up to 27% of financial variances in earnings, revenue, and asset returns. In addition negative word of mouth advertising can cost upwards of $400,000 in revenue loss throughout a patient’s lifetime. Quality literature also recommends empowerment of line-level employees, through self-management. In quality literature however, there is only fractional discussion to participation by non-managerial users. Many managers, including top executives, have difficulty delegating authority and responsibility down through the organization. To resolve, information control which once gave middle management power where decisions were made up the chain, can be completed by the individual employees [21, 27-29].

Due to the complexities of healthcare application architectures, effectiveness and positive outcomes of BIS are not a given. Healthcare software and hardware vendors are considered less mature than in other industries. Additional healthcare challenges include technology, leadership, resource allocation, governing structures, healthcare practices changes, and social challenges. Research analysis has shown the importance of research within the healthcare context, when compared within more general IS research. A vast majority of studies focused on IS theory building or reference within a healthcare setting, which suggests the healthcare industry has differing intentions and organizations than traditionally studied IS industries. While traditional formulation and testing of IS theories have focused their attention on studies of social context, organizational systems, national organizations, socio-economic, government, or culture influences, relatively few have focused on interaction of IS with regard to industry characteristics. Healthcare industry characteristics and organizations differ significantly from traditional IS studies industries such as manufacturing, airlines, financial, and information technology. The healthcare industry has additional regulatory requirements, national differences, structure, financial profit models, and professional roles of medical and administration staff. The complex healthcare structures increase complexity for information systems development and implementation. Healthcare measurements include cost, profit, customer satisfaction similar to other industries, but also include social measures including quality of life, disease prevalence, and overall health. When considering existing IS theory, topics, and constructs within healthcare, theories require reshaping and modification to details with specific contextual issues. General theory development poses challenges when applied to healthcare research, as the theory must be beyond the healthcare context, which social scientists have questioned as viable [30].

Health information systems research (HISR) describes the multidisciplinary body of knowledge related to design, development, implementation, and use of information systems in healthcare, with the largest contributor being medical informatics described as optimal problem-solving and decision making using biomedical information. The field draws from medicine, computer science, and information science, sociology, diffusion of medical technologies, information systems, health science, and information science. Analysis of HISR publications within IS showed a small but growing literature set. HRIS analysis also recommends utilizing both generalized and specialized theory, due to the technical and institutional requirements of traditional firms vs. healthcare in IS research. IS theory may be modified to apply to the healthcare context, and also more general to apply beyond healthcare. In healthcare, IS theory is often far from practitioners and researchers, and healthcare context is far from many IS researchers. Development of healthcare contextual research within IS is recommended to build theoretical bridges to assist with information collaboration and exchange [30].

Current industry research supports the notion of democratization, which is the idea of allowing information to be available to all stakeholders, driving improved learning across the organization. Resource-based view and extended dynamic capabilities, discusses how resources are utilized within a firm for sustained competitive advantage. IS are key to adapting in dynamic environments, and development, integration and release of resources. Leading vendors have recently deployed software aimed at bringing BIS capabilities to all users in order to increase efficiency and decision making. In the past these vendors focused on technology experts only, but now attempt to cater to everyone in the organization. In a recent Gartner survey [17], the majority of respondents indicate that improving decision making through social software and collaboration is a top trend as opposed to formal, top down decision making. Savvy IT leaders are driving this change, as they exploit current interest in sites such as Facebook which allow collaboration and sharing. Meanwhile data used for decision making, traditionally was pulled from only databases, but now comes from a variety of sources [17, 18, 31, 32]. We hypothesize these fundamental shifts and associated improvements within BIS will lead to enhanced learning, a quality organization, and competitive performance.

II. LITERATURE REVIEW

Literature review from healthcare, BIS, learning, quality, and competitive performance were utilized to develop the research model and relationships between those areas. BIS literature added studies which described learning through BIS usage, and the evolution of earlier information systems to BIS. Learning literature discussed theories to the way individuals and organizations learn. Healthcare literature described the current challenges and opportunities facing healthcare, as well as the quality imperative contained within the healthcare framework. Management and organizational literature discussed the individual and system attributes which effected success and had a BIS impact on learning and competitive performance.

2.1 Road to Business Intelligence

Beginning in the late 1960s, experiments began with Decision Support Systems (DSS), utilizing computers to analyze data and offer decision-making support. DSS were typically used for narrowly focused activities such as production planning, investment management, and transportation applications. With the introduction of software applications such as SAS and SPSS in the 1970s, statistical software became more available and accessible to end users. Despite this introduction, DSS did not prosper and evolved into Executive Support Systems (ESS). ESS were utilized by executives for viewing performance and focused less on decision making support. ESS also didn't enjoy widespread usage due to resistance by executives to hands-on usage. Since then, data warehousing and querying is most frequently used to monitor performance and decision making support. The entire field today is known as Business Intelligence (BI) and includes collection, management, and reporting of decision making data and information. BIS are the number one technology priority for organizations according to industry surveys [8, 33].

As organizations looked for new sources of competitive advantage and differentiation they turned to data, which was becoming more available than ever before, through use of Enterprise Resource Planning (ERP) systems, point-of-sale (POS), web, and other transactional and operational systems. This data was commonly fragmented, incomplete, and in a non friendly form to users. Unbeknownst to users at the time, this data was a significant organizational asset, which would later be leveraged for success and competitive advantage. In order to realize these benefits however, the data must be developed into an enterprise wide unified view. Construction and integration of knowledge is a key to succeeding in the competitive global market. Information Technology moved to support day-to-day operations and all aspects of decision making, with differentiation through technology becoming increasingly important [8, 33].

Firms have made major investments in such systems as enterprise resource planning (ERP), supply chain management (SCM) and customer relationship management (CRM), yet struggle to achieve competitive advantage. Firms need streamlined access and analysis of the underlying information in order to make operational decisions. Strategic organizations sought to improve efficiency through faster and better-informed decision making, and looked to technology to enhance strategic and tactical results to improve time to market, connectivity, integration, and visibility into their business. New generations of technology savvy users and executives were finding ways to utilize previously untapped information [8, 33].

ESS were utilized to provide senior managers relevant information to their activities. Decision making is an important role for executives; however they must rely on information systems for their decision making in a data-centric world. Decision support systems were in place in the late 1970s and are found in most organizations. However DSS tend to focus only on a particular decision or set of decisions, and several inputs are required to prepare the analysis [34].

The feature found in most ESS was single database access with current organizational information, in an easy to access manner. ESS usage was also found to be positively related to problem identification, decision making, and analysis. Other ESS features included non-keyboard interface, organizational database, drill-down capabilities, trend analysis, exception reports, graphics, and critical information monitoring. The focus of an ESS was on the organizations day-to-day activities as well as marketplace indicators. A DSS by contrast was intended to allow on demand decisions and routine analysis [34].

ESS are sometimes referred to as high-risk/high-return systems, as the systems serve executives whose information needs are complex, but also have greater influence. Organizations and executives require constant information to quickly and proactively respond to technology, competition, regulation, and economic changes. ESS provide executives easy to use information that supports their critical success objectives. The identified critical success factors of ESS included sponsor support, timely data, and overcoming political resistance. Continuous and detailed interaction was required between executives and developers to ensure operational success. Data management, requirements documentation, easy to use interface, relevant, accurate, and timely data was also required. Prototyping was recommended to capture executive interest at the highest level [35].

2.2 Business Intelligence

BI is not a single product, application, program, user, area, or system, rather an all encompassing architecture of integrated systems and methods that provide all stakeholders with information for decision making and learning. Competitive pressures cause organizations to continually improve and adapt in order to be successful in the ever changing business environment, and information is required by employees throughout all levels of the organization for ongoing decision making [4, 6, 8, 36-38].

BIS refers to applications and technologies used to gather, capture, access, consolidate, and analyze information to improve decision making. These systems capture important metrics on business operations, as well as providing a mechanism for improved decision making. At the various levels these information items may include documents, calendars, wikis, links, reports, dashboards, scorecards, search, databases, lists, user knowledge, and much more. For example, these technologies can help coordinate projects, calendars, schedules, discuss ideas, review documents, share information, keep in touch with others, utilize Key Performance Indicators (KPI) to gauge operational status, and generate reporting information on-demand. The BIS process is one that allows large amounts of disparate data to come together into a single repository and turn that data into meaningful information for decision support processes. BIS can include various forms of analysis, data mining, scorecards, dashboards, metrics, reporting, portals, data warehouse, OLAP, decision support, knowledge management, etc. This information is available to all levels of the organization and associated stakeholders, on-demand, and in an easy-to-use fashion [4, 8, 38, 39].

BIS are becoming more critical to organizations. These capabilities are utilized to increase power of workers to make decisions on factual data. Typically however, only a fraction of this data is housed, and a significant portion resides within firm employees, requiring systems to capture, store, and disseminate this data. The effectiveness of BIS will be measured on its ability to promote and enhance knowledge, mental models, decision making, learning, and ultimately firm performance [40].

Table 1. Business Intelligence System Comparison Summary

BIS Component	**DSS**	**ESS**	**BIS**
Knowledge Management			X
Content Management			X
Performance Management		X	X
End-User Tools	X	X	X
Querying / Reporting	X	X	X
Analysis	X	X	X
Database Management System	X	X	X

Table 2. Business Intelligence System Components

BIS Components	Description
Online Analytical Processing (OLAP)	Multi-dimensional analysis; "slice and dice"
Data Mining	Uncovering hidden relationships and patterns in data
Predictive Analysis	Identify future values or events, based on historical data
Business Analysis	Understanding of business problem or opportunity
Statistical Analysis	Hypothesis testing on numerical data
Geospatial Analysis	Geographic or time based data review
Scorecard	Ties operations with strategy; multiple KPIs
Strategy Maps	Illustrates cause and effect of key indicators; long-term strategy with operational activities
Key Performance Indicators	Metric tied to a target
Querying	Data retrieval programming
Reporting	Output used to analyze raw data
Knowledge Management	Information collection and management
Portal	Central landing point
Dashboard	Focus on operational goals; visual summary
Charting	Way of presenting data via graphic
Data Warehouse	Collects and stores data from various sources
Data Mart	Single distinct collection of data
Operational Data Store	Transactional storage for operational purposes
Content Management	Storage and retrieval of information
Search	Location of information
Operational System Integration	CRM, ERP extensions and integration points
ETL	Extract, Transform, Load data processing
MetaData	Data about data

2.3 Transactional Systems vs. BIS

Many companies store data readily, yet struggle to utilize this information in meaningful ways. Transactional systems are often relied on to review information and make decisions, however these systems are often ill-equipped. Transactional systems are not designed for advanced analytics and business intelligence, and impact technical infrastructures through increased complexity to allow for business intelligence. Specialized BIS are required to conduct ad-hoc analysis, data mining, and complex queries across multiple datasets. Transactional systems are optimized for transaction processing and write speed. BIS are designed for immediate access to volumes of data and read speed. These systems work in conjunction with one another to achieve best results and firm performance [41]. The figure below describes the common components contained within a transactional and BIS.

2.4 Learning

Mental models are psychological representations of real, hypothetical, or imaginary situations, and the individual representation used for reasoning. Mental models allow users to understand phenomena, make inferences, respond appropriately to a situation, and define strategies, environment, problems, technology, and tasks. An example of a definition problem may be resource allocation or organizational strategy. These mental models can be based on one's belief of the truth, and are often simpler than the represented phenomenon, composed of knowledge/behavior/attitude, created through interactions with the environment. Mental models influence behavior and create reasoning basis, which improve human decision making, by allowing pre-defined models, which speed information processing. This permits information systems to fill in any gaps, and improve information management. Some drawbacks may include human bias to confirm pre-existing models [18, 23, 24].

Write - Optimized | Read - Optimized

Component	Transactional	BIS
Spreadsheets	Basic	Advanced
Database Management System	Basic	Advanced
Operational Data Store	Basic	Advanced
Operational System Integration	Basic	Advanced
Reporting	Basic	Advanced
Querying	Basic	Advanced
Charting	Basic	Advanced
Portal	Basic	Advanced
Operational Data Store	Basic	Advanced
Search	Basic	Advanced
MetaData	Basic	Advanced
Online Analytical Processing (OLAP)		Advanced
Data Mining		Advanced
Predictive Analysis		Advanced
Business Analysis		Advanced
Statistical Analysis		Advanced
Geospatial Analysis		Advanced
Scorecard		Advanced
Strategy Maps		Advanced
Key Performance Indicators		Advanced
Knowledge Management		Advanced
Dashboard		Advanced
Data Warehouse		Advanced
Data Mart		Advanced
Content Management		Advanced

Figure 1: Transactional Systems vs. BIS

BIS are intended to provide all stakeholders with high quality, easy to use, and relevant information for decision making. They are flexible enough to provide support for a variety of user requirements. To measure their success, one may gauge whether they help users learn. Learning is defined as a purposeful remembering displayed through skillful performance, and measured as potential change in performance behavior, as the change may occur at a point in time after the information is collected [18].

In order to gain insight into how BIS support competitive performance, it is important to understand which factors distinguish mental model development. Competitive performance can be operationalized at a lower level to improve survey results. Future research can determine how mental model maintenance influences performance such as efficiency, effectiveness, innovation, and consensus building, due to its multidimensional nature and assumption of benefit. Authors recommend quantitative and qualitative research, as well as case studies to understand why information systems are used and the results of those systems, as well as allowing more precise operationalization of constructs for measurement and observation. Here, the view of success is based on learning rather than typical metrics of usage and technical characteristics such as accuracy, timeliness and reliability [18].

Organizational learning has become a critical component of enhancing the competitiveness of a firm. Organizational learning is a key strategy in enhancing competitive advantages, achieving superior performance, and sustainability [42]. Organizational learning can be regarded as a group of people who decide to enhance their capabilities to produce desired outcomes. Organizational learning refers to a set of measureable changes, and closely match individual learning models. Specifically key aspects of organizational learning include the ability to develop goals, modify goals over time, and monitor progress of common goals. Individual learning and organizational learning effectiveness can be measured similarly. For example, when an individual is able to set a goal, monitor, progress, and achieve that goal they are deemed effective at learning. Similarly, when an organization is able to set goals, monitor, progress, and achieve those goals they are also able to be effective [43].

A required component of organizational learning is individual learning. In individual learning, mental models are used and cannot be directly shared, but rather represented thereby enabling others to observe, share, and investigate. A learning organization allows individual to use facilitating tools to allow organizational observation and representation of structure and performance. Individual in an organization form their own mental models, but also observe and share mental models with others, eventually resulting in a shared vision of common goals. Diffusion and manifestation of ideas over time is a key indicator of a learning organization [43]. Organizational theorists recognize that individuals process and interpret information, yet assume that organizations are beyond mere individuals due to individual changes, with organizational knowledge, behaviors, mental models, and visions. The distinguishing feature can be classified as sharing, many sub-systems exist for completing tasks and requirements, which is then converges and is aggregated at an organizational level [44].

Organizational learning has increased complexity over a simple extension of individual learning. This complexity is evidence as the scope is broadened from a single individual to a group of individuals with varying characteristics. Learning terms remain similar, though the learning process is changed at an organizational level, with the organizational learning vs. an individual. As an organization increases the number and background of individuals, and increasing shift occurs from individual learning to organizational learning. A seemingly apparent conflict arises, such that an organization is more than just individuals, and an organization exists only through its individuals. In an integrated model proposed by Kim (1993), individual learning effects organizational level learning through changes in shared mental models. Organizational memory in the form of shared mental models are then accessible by the organizational, and continually improved by individuals learning, with the entire process independent of any one individual. [45].

To achieve organizational learning, a commitment to learning must occur through employee training, development, and vision. Shared visions throughout the organization, and open mindedness to encourage innovation and follow consistent practices. The organizational learning process includes aggregation of internal and external information, which is then analyzed and interpreted collectively to allow organizational comprehension and consensus, and incorporated into activities [46]. Structural and sociological issues have traditionally limited organizational learning in health care. New systems of care delivery and reimbursement are requiring physicians and providers to collaborate with others. Organizational learning is required, along with information systems to ensure clinical, economic, and customer satisfaction information is measured to improve quality and cost of care [47].

Organizational learning can be driven by technology, and help improve other output measures beyond financial measures, to measures such as such as quality or new business opportunities. Learning organizations are competent is systematic problem solving, attempting new approaches, learning from past experience an best practices, and knowledge transfer, which can by driven by information systems. Historical measures of learning focused on learning curves or cost of goods reduction, however these measures only provide a partial picture. To accurately measure learning, organizations must also include variables such as quality or innovation. Organizational learning is able to be tracked over cognitive, behavioral, and performance improvements, with cognitive and behavioral changes leading to performance through new ways of thinking and methods. Surveys, questionnaires, interviews, and performance measures must be utilized to accurately gauge organizational learning [48].

Theories of learning have developed from behavioral theories to knowledge application theories. The set of cognitive theories studies information organization in memory, learning, and decision making in an effort to maximize learning. Situative or situated learning theory is concerned with organizations instead of individuals, and views cognition as a component of a collection of individuals and the environment. All interactions and activities are determined utilizing the available information and artifacts, and learning can take place though any social activity. An organization following the situtative approach would develop collaborative learning environments, where learning is encouraged and knowledge valued. Cognitive flexibility theory (CFT) is intended to describe learning in complex domains, and where knowledge application requires interaction of multiple complex components. CFT is based on constructivism, where learners develop models of reality and incorporate meaning based on prior knowledge. CFT promotes constructive processing which allows flexibility with regard to combining prior and current information to the specific application. This concept is required in advanced knowledge domains, where everyday problem solving must adapt to changing contexts and requirements. Healthcare is an example where complex medical tasks require various strategies to diagnosis conditions and identify all potential factors involved [13].

2.5 Use vs. Learning as a Success Measure

In DeLone and McLean (2003) IS Success review, some authors discuss removing system use as it is a behavior and must precede net benefits, but does not cause them. DeLone and McLean argue that use is appropriate for a success measure. One of the challenges is that use is a simplified approach to a complex component. Implications that increased use will lead to increase benefits is unlikely without determining the factors that go into use such as type, duration, intention, etc. In DeLone and McLean use measures effectiveness success, with use capturing a variety of tasks such as web visits, information capture, or transactions. DeLone and McLean recommend for each individual research study, IS success measures should be based on the investigation and tested where possible. Use should not measure frequency alone, but instead capture the nature, level, and appropriateness of usage. Also practical research should be conducted to expand net benefits ideas [49].

In Vandenbosch and Higgins (1995), the authors found that performance from ESS use were only related to mental model building, but not mental model maintenance, implying that use alone may not affect learning models. The description is that learning developed from any system cannot occur unless through using said system to some degree. The view of success is not simply that the system is used, but rather that they contribute to learning, which was viewed as a more appropriate way to measure success [18].

2.6 Healthcare Services Review

As one of the major efforts to reduce healthcare costs and ensure consistency between healthcare entities, Electronic Data Interchange (EDI) standards have been created for healthcare information exchange. The Health Insurance Portability and Accountability Act of 1996 (HIPAA) includes provisions for Administrative Simplification, which require the Secretary of Department of Health and Human Services to adopt standards to support the electronic exchange of administrative and financial health care transactions primarily between health care providers and plans. Transaction standards and specifications were adopted by the secretary to enable health information to be exchanged electronically. Implementation Guides for each standard have been produced at the time of adoption, and consistent usage of the standards including loops, segments, data elements, etc., across all guides is mandatory to support the Secretary's commitment to standardization [50].

Healthcare services reviews are typically exchanged through the 278 HIPPA EDI transaction set. Business events covered under the HIPAA 278 healthcare services and review transaction include: admission certification review request and response, referral review request and associated response, health care services certification review request and response, extended certification review and response, and dental referrals and certifications. Additional business events can be represented, as well as notification such as patient arrival, patient discharge, patient certification change, and certification notice to provider or utilization management organization. In a typical process, information is sent from the requesting entity such as a primary provider and received by a receiving entity which can determine the outcome of the request, such as an utilization management organization or service provider. Information can flow bi-directionally to allow for inquiries on pending certifications, as well as response of certification result. Both batch and real-time information may be sent between entities, however real-time is preferable due to immediate result during patient presence and processing [51].

2.7 Healthcare Information Systems

Traditionally, healthcare organizations investments in information systems have lagged any other information-intensive industries such as financial or aviation industries. During the late 1990s, investment by American industry in information technology was an average of eight times higher per worker than within the healthcare industry. Despite additional spending on health information technology, there are still issues relating to costs, errors, efficiency and coordination of care, which reflect the limited saturation of health information technology within healthcare systems. For example, inefficient paper based systems, inaccessible medical information during care, limited patient access to health information, misinterpreted handwriting and unavailable best treatment options affect current healthcare systems [52, 53].

Most current hospital systems have little to no clinical decision support, such as patient information displays, alerts, reminders, and guidelines. Studies have shown that computerized reminders are useful in chronic care, and healthcare safety is improved through checking common problem areas and key abnormalities. Computerized decision support can also improve both efficiency and quality of healthcare through real-time access to information that is highly integrated. Typically those systems cannot easily communicate between one another, which makes extracting data for decision support even more difficult. In addition, communication aspects are also improved between patients, providers, and hospitals. Through integration of multiple electronic data sources, patients can be proactively identified for certain conditions or issues [52].

Healthcare stakeholders promote the use of HIS as a way to provide safe, affordable and consumer-oriented healthcare. This includes avoiding medical errors, the improved use of resources, accelerated diffusion of knowledge, reduction in access variability, consumer role advancement, privacy and data protection, and public health and preparedness. HIS have been shown to decrease billing issues, medical and drug errors, and improve patient health, use of medical evidence, cash flow and collections, paper cost, quality, safety, research, compliance, and preventative care. In addition, the need for quality measures is driving HIS adoption. Increasingly, providers are being measured on quality, and that quality is tied to pay for performance or other programs that directly affect the payment to the provider. EHR systems make quality measures available for reporting and compliance requirements. In perhaps one of the largest EHR implementation case studies, the Veterans Health Administration showed improvements in employee-patient ratios and cost-per-patient decreases as compared with the US consumer price index increase. Quality also is improved through preventative screening measures and disease management [53].

Today, health care organizations are becoming increasingly computerized, thereby capturing increasing amounts of data in various places. In other industries, information systems use increase, can be tied to improved quality and competitive advantage. Extracting, formatting, analyzing, and presenting this data, can improve quality, safety, and efficiency of delivery within a healthcare system. For example BIS has been used in radiology to address the complex, poorly integrated, and functionally limited legacy systems as practices transitioned from analog to digital. BIS allow the decision making to develop trends and interactively perform drill downs to answer further questions as they become apparent. Procedural and performance metrics can be tracked to improve patient care and reduce costs. Some examples include resource utilization by scanner, time variances between scheduled and actual time, evidence-based outcomes, billing tracking, and quality outcomes measurements such as length of stay and charge costs [52, 54].

Recent driving forces by technology-enabled stakeholders, have created electronic medical records as a component of HIS, and allowed access by patients, providers, and affiliated users. It is believed that access to information will allow patients and providers to have joint responsibility for health records, including up to date information, and self-management of conditions, ultimately leading to active management of care and improved quality. Literature has shown the right information in the hands of patients, providers, case managers, and others leads to improved patient outcomes and quality. The introduction of information systems to collect, store, and analyze data, has also allowed payors and administrators to track providers against their peers to create accountability for evidence-based medicine and best practices for quality of care [55-57].

2.8 Healthcare Organization Quality

Quality has become an organizational phenomenon over the past few decades, due to increasing competition, uncertain business environments, technological advances and stakeholder requirements. Quality occurs through meeting and exceeding past, present, and future stakeholder requirements. A typical continuous improvement cycle includes developing stakeholder requirements, meeting those requirements, measuring success, and periodic reevaluation of requirements for improvement identification. Quality traditionally was used to describe products, but has been extended to include stakeholder expectations and associated satisfaction. In order to exceed stakeholder requirements beyond simply contractual or legislative items, organizations are monitoring quality of organizational service offerings. The past decade has given rise to a notion of a quality organization, in which goods and services must achieve the highest possible quality throughout the organization [7, 21, 27, 28, 58-60].

Global competition has required organizations to implement quality services, products, and programs. Total quality management (TQM) which contains a similar set of practices across industries, began in the 1980's, and improved organizational positions by superseding global competition and environment changes. Total quality management may be defined as continuous improvement of quality throughout all systems and processes, with active participation by all levels and units of stakeholders internally and externally to the organization, and through information integration and quality outputs. For organization wide total quality, cross-functional management and communication structures are required, in order to bring together competing priorities, and range of individual abilities to achieve set objectives. When total quality management fails, it is typically due to missing complementary resources required for competitive advantage. In order to succeed and achieve organizational quality strategies, strong backing by top management, information systems, and a stakeholder focused culture are required. Additional requirements include application of quality assurance and improvement to all organizational subsystems, such as individual department or business process areas.

However, typically either individual subsystems are reviewed, or the total integrated system is reviewed, versus a preferred look at each individual subsystem, with total integration secondarily [7, 21, 28, 58, 59, 61].

Organizations must link strategies, actions, and measures in order to achieve quality benefits. Performance management components should be based on the organizational success factors, and tracked systematically. Healthcare service organizations experience additional difficulty in process identification and management due to low IS utilization, whereas historic manufacturing organizations have high utilization of IS, such as ERP, SCM, and CRM systems to measure performance. In a healthcare setting, IS can be used to connect employers, healthcare providers, and patients to efficiently monitor and manage patient status during treatment and employment return. One framework for assessing and improving organizations for sustainable advantage is the Excellence Model Framework. The framework identifies many ways to achieve sustainable excellence, and key concepts include: results orientation, customer focus, leadership and constancy of purpose, management by processes and facts, people development and involvement, continuous learning, innovation and improvement, partnership development, and corporate social responsibility. Organizational excellence is optimal usage of resources and information to maximize results, with increasing levels of stakeholder interaction, to allow continued performance [21, 62].

Despite the need for quality, TQM has led initially to high levels of turnover. Organizations must find ways to continue to motivate and retain employees, with employee participation a critical component to quality, and the associated personal enrichment which goes along with direct involvement and decision making. In an employee improvement process, individual transformation and understanding of knowledge will occur, in which the individual will add new meaning to events and interactions. Second, they will have a judgment and decision basis for organizational transformations. They will also assist others to move into similar practices and capabilities, leading to improved organizational quality. In one case example, a quality database was developed to track and provide updated information to employees for improving quality. As a result of the employee's quality efforts and assistance of information systems, rejection levels were reduced from 10% TO 5% [27, 59].

Quality of health care delivery and rapid, measurable, and sustainable improvements are a high priority for health systems. Like quality in most services, healthcare quality is difficult to measure owing to inherent intangibility, heterogeneity and inseparability features. For example, quality in healthcare is more challenging to determine than in financial or aviation industries, as in healthcare the output is individually perceived quality of life. AHRQ identifies improving quality of health care, and ensuring no one is left behind in quality improvement, as two key public policy challenges. Required annual congressional NHQR and NHDR reports, examine health care system quality and disparities through key measures. The reports identify several improvement areas such as recommended cancer screenings, nutrition counseling, environment changes to improve asthma related conditions, and recommended diabetes screenings. Overall access and quality of care is often determined based on racial, ethnic, or economic grouping. Successful quality improvement has been demonstrated at a state and national level, and most measures of quality are improving, however at only a modest pace, with a 3.1% improvement rate over the last 3 years. AHRQ has turned to more advanced information systems capabilities through web-based tools and improved data, graphing, and reporting, to increase access and insight into quality trends. For example, state snapshots, allow graphical dashboard comparison of measures, and identify quality improvement areas [29, 63].

Organizational variables are often used to explain patterns and differences in quality of care. Research has identified the importance of system and organizational influences on provider beliefs and behavior towards implementations [16]. Quality improvement proponents have recommended a healthcare quality information system (HQIS) to accurately measure and mange healthcare quality information collection, analysis, and reporting. Outcomes and treatment cost improvements exist, and the public is seeking more information regarding healthcare quality, in order to make informed decisions. To ensure successful HQIS, hardware, software, and a complete information framework of standard data fields and processes must be developed [64].

A number of studies have identified patient views and satisfaction as a tool in monitoring and improving healthcare quality. A patient-centered data structure is often implemented, linked by a patient id, and utilized to manage quality of care. Quality typically includes both a technical dimension, and a functional dimension. Patients may be unable to accurately determine technical quality, and typically functional quality is used as the primary method. Despite much literature on healthcare quality, few tools exist for assessing and managing said quality. Within the healthcare services review sector, direct patient care is affected, and key components of quality are supported through BIS capabilities [29, 64, 65].

2.9 Quality Organization Management

To achieve a quality organization, healthcare entities must balance the needs of various stakeholders. For example financial returns must be weighed against quality of care provided to customers, and training provided to employees. Within service sectors such as healthcare, employee requirements, resulting interaction with customers, and impact on shareholder returns all must be considered with a greater degree. Other industries have experienced similar challenges in balancing stakeholder requirements. For example, financial companies such as Citigroup, Goldman Sachs, and Bank of America, were recently targeted for allocating large contributions directly to employee salaries in preference over shareholders. The average payout ratio for employee compensation was roughly 60 cents per dollar, similar to retail and healthcare, though payout ratios vary widely, in some cases exceeding total profit [66].

Due to competitive markets and globalization, organizations must continually seek to add value to their services, deliver additional profits, and exceed customer expectations. Satisfied employees tend to be more involved and dedicated to quality. Presenting positive employees leads to a positive customer attitude towards a given product. Dissatisfied or hostile employees create hostile customers regardless of the organization's tasks and service performance. Customer satisfaction has also been shown to have a long-term profit impact. Satisfied customers are more likely to purchase in greater quantity, with greater frequency, and add additional services. Satisfied customers are also more willing to pay premiums and are less-price sensitive than non-satisfied customers [67].

2.10 Organization Information Processing Theory

Organizational information processing theory addresses the ability to satisfy information processing needs and is a major task in organizational design. To resolve uncertainty, the organization must take steps to reduce information needs, or increase information processing capability through information systems. The information system output may be a vast amount of information detail, as well as capabilities for identifying required information. Uncertainty can be describes as limited information regarding tasks, environment, etc. and may change between individuals and units of the organization. OIPT identifies performance benefits from integrated and standardized information systems, and are related to interdependence between organizational units. Interdependence can be described as the level to which units share information in order to complete their appropriate tasks. In situations of low interdependence simple procedures are acceptable, however high interdependence requires increases information requirements. Firms have implemented ERP and other information systems to improve information flow and develop standards for improved information exchange by removing conversion or translation needs [16, 56, 68].

Information quality is vital as for organizations to reduce uncertainty and enhance their decision making capabilities. System quality is addressed through information processing needs, or the supported communication requirements based on individual and unit interactions as well as system support for information processing capability through use of technologies. Service quality may also be described through information processing capability through the information technology support given to end users to assist with performance outcomes [69].

2.11 Knowledge-Based Theory

The main intention of the knowledge-based view (KBV) of the firm is leveraging knowledge for improved net benefits. Knowledge may be defined as the repository of intellectual assets which have been combined from experience, learning, and practice. Knowledge is often described in terms of data and information; however knowledge can only be distinguished through an individual's personalization, and interpretability to others. Increasing amounts of information are only useful when processed by an individual through learning processes. Knowledge is also often the basis for quality improvement activities within the organization. Under conditions of uncertainty and complexity, total quality control and total quality learning have been found to result in improved performance over total quality control alone. Quality is found to influence organizational performance through effective deployment. The Knowledge Based View of the firm provides a theoretical basis for this concept, in that quality management leads to knowledge generation and associated performance [70-72].

Human knowledge may be classified into explicit and tacit knowledge. Explicit knowledge is easily transferred, whereas tacit knowledge is difficult to transfer. Explicit knowledge is codified and may be transmitted in a formal language. Tacit knowledge is personal, making communication in a formal language difficult. Tacit knowledge includes cognitive elements and technical elements. The cognitive elements include mental models, in which beliefs, viewpoints, paradigms, and schemas help an individual to see their world, and develop reality and visions for the future. The technical elements involve know-how, crafts, and skills in specific settings. At the lowest level of grain, knowledge is developed through individuals, to which the organization supports individuals and provides a forum for knowledge creation and exchange, and amplifies individual knowledge at an organizational level. Knowledge begins with the individual, then flows to higher-level groups, organizations, and inter-organizations. Knowledge conversion was developed from the ACT model in cognitive psychology. There knowledge is separated into declarative and procedural, roughly matching explicit and tacit respectively. The ACT model proposes that declarative knowledge must be transformed into procedural knowledge to acquire cognitive skills, and is similar to know-why vs. know-how [20, 71].

Knowledge creation can be described as an interacting spiral between explicit and tacit knowledge, including socialization, externalization, combination, and internalization. Socialization, or tacit to tacit interaction, involves sharing experiences and creating shared mental models. Socialization requires individual interaction through discussion, mentoring, observation, imitation, and practice. Externalization, or tacit to explicit interaction, involves the use of metaphors, analogies, concepts, or models, and is known as conceptual knowledge. Combination, or explicit to explicit interaction, may be developed through sorting, adding, combining, categorizing existing explicit knowledge. Internalization, or explicit to tacit knowledge, involves utilizing documentation, manuals, or stories, and internalizing the knowledge. Internalization may occur thorough learning by doing, and referred to as operational knowledge [20, 71].

III. MODEL & RESEARCH DESIGN

3.1 Overview

This study seeks to model healthcare industry components, and more specifically includes the healthcare services review decision process and associated support/administrative processes, as the basis for BIS, organizational learning, healthcare quality, and competitive performance. Healthcare services reviews are typically exchanged through the 278 HIPPA EDI transaction set. Business events covered under the HIPAA 278 healthcare services and review transaction include: admission certification review request and response, referral review request and associated response, health care services certification review request and response, extended certification review and response, and dental referrals and certifications. Additional business events can be represented, as well as notification such as patient arrival, patient discharge, patient certification change, and certification notice to provider or utilization management organization (WPC 2000). This is a critical administrative component of care, more largely known as Medical Management, with decisions made that affect coverage and access to care, and is intended to improve quality and cost of care. The healthcare services review decision process begins with data entry or electronic transmission, online through a web-based interface either directly by the provider of service or the review organization. The next phase may include automatic decision rules, and/or non-physician determinations. Upon physician decision, an appeal may be levied upon presentation of additional information or re-review, in which case the initial decision may be upheld or overturned. As the number of decisions in the healthcare services review process increase, the overall cost and time increase. Key Performance Indicators (KPI) are tracked to monitor performance, improvement, quality, and competitive performance. The process is shown in the figure below.

The services covered under medical management include utilization management, case management, disease management and services reviews. Medical management also includes the associated systems which permit integrated delivery of care and information, which support quality and cost improvements, and HIS applications have been found to improve medical management programs. While much progress from paper to computerized systems has occurred over the past decade, further analysis found that a low percentage of organizations had a truly integrated system, with information and data readily accessible to clinical and administrative staff [73].

During interviews with executives, managers, and professional staff, before, during, and after BIS implementation and from review of prior literature, a path-analytic BIS learning model was proposed as shown in Figure 1. Literature review from healthcare, BIS, learning, management, and information systems were utilized to develop the research model and relationships between those areas. The model displays the impact of BIS information quality on perceptions of healthcare quality and competitive performance when utilized to support organizational learning. A path-analytic model with latent variables is chosen to allow assessment of validity and determination of hypothetical constructs. The model also accounts for variable measurement error, to allow the underlying relationships to be measured rather than the individual manifest variables, by removing the error variance from the latent factors and modeling separately. Information quality is included as an antecedent to learning in the model. The objective of this paper was to better explain the elements which influence learning models, and if organizational learning, healthcare quality and competitive performance are dependent on BIS characteristics.

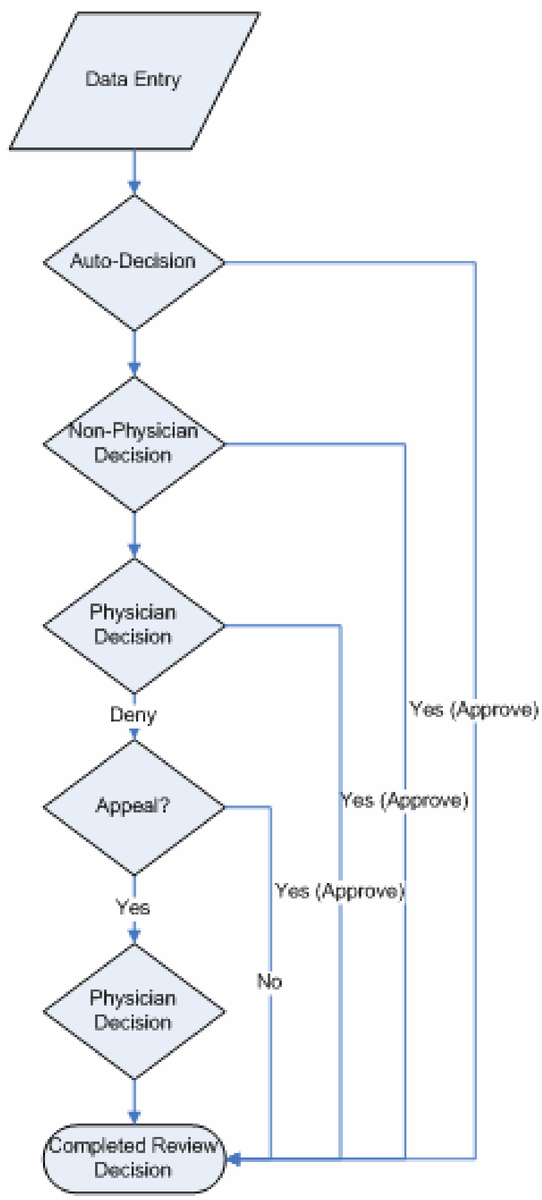


Figure 2: Healthcare Services Review Decision Process

3.2 Model Design

DeLone and McLean (1992, 2003) identified factors which contribute to information systems success, and developed a model to combine various segmented research studies into the topic of IS success. Their overall model consists of 7 main components for IS success: system quality, information quality, service quality, use, user satisfaction, individual impact and organizational impact. The authors recommend that dependent and independent variable selection should consider organizational strategy, structure, size, environment, technology used, task characteristics, and individual characteristics. DeLone and McLean (2003) also introduce the notion of net benefits as the most important outcome, which incorporates overall IS impacts beyond the initial user, and include all stakeholder impacts of IS. The impacts which are measured should depend on the systems and purpose of the study. The model is shown in the figure below [49, 74]. For this study, this model is relevant to providing factors and measures for BIS antecedents to learning, with healthcare specific net benefits of quality and competitive performance.

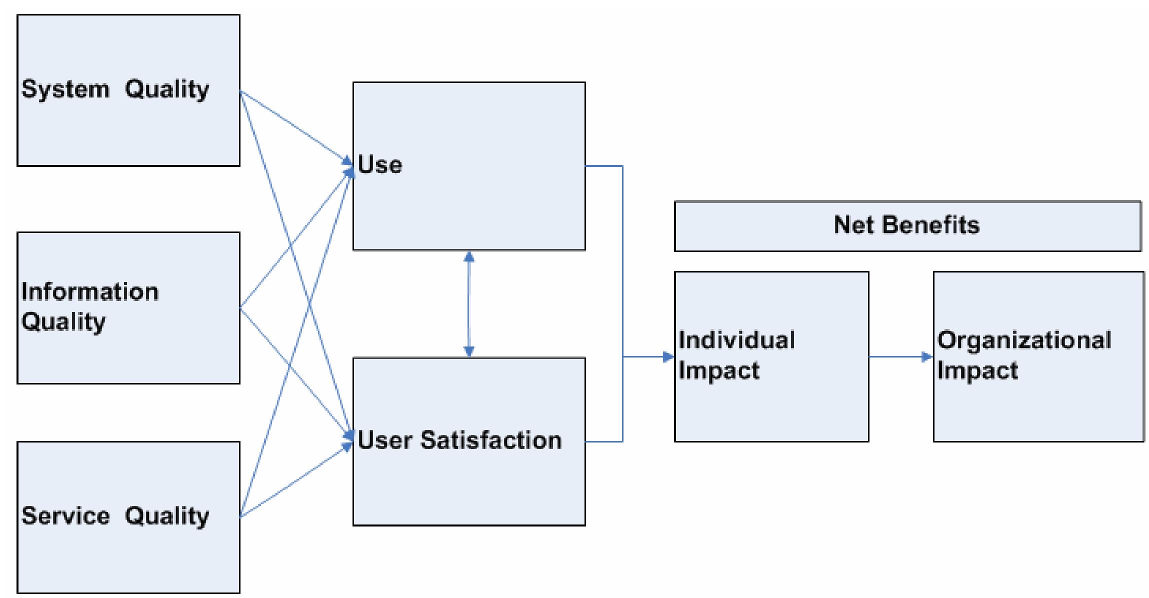


Figure 3: IS Success Model

Vandenbosch and Higgens (1995) studied ESS and associated success, a precursor to BIS. The authors incorporated a learning construct to gauge individual impact. While both mental-model maintenance and mental-model building contribute to an organizations success, maintenance is considered to be the more likely behavior, and implies routine use of the learned techniques. Model-building however is found to be of higher risk in organizations, and benefits are more difficult to produce. New organizational endeavors or areas of interest have longer life spans and a higher degree of uncertainty. Competitive sustainability requires the ability to explore model-building, but also relies on the organizations ability to continuously monitor performance. Organizations should ensure the appropriate criteria is in place to promote mental model building and mental model maintenance [18].

Vandenbosch and Higgens (1995) found significance with regard to mental model building, but not mental model maintenance. Possible explanations for no significant link between mental-model maintenance and perceived competitive performance when utilizing ESS include: high-level operationalization of competitive performance in the survey, competitive performance attributable to mental-model maintenance is too small to measure, executives utilize varying information sources and do not relate competitive performance to ESS use, previous management literature suggests that mental-model maintenance is not as critical to long-term competitive performance as with mental-model building and survey items may have influenced a long-term perspective when considering competitive performance [18].

The presence of an analysis capability was identified by Vandenbosch and Higgens (1995) as the best method for differentiating between mental-model maintenance and mental-model building. In order to aid comparison of pre-existing research of ESS with BIS, the prior model by Vandenbosch and Higgens (1995) is utilized as shown in the figure below [18]. BIS is seen as having improved analysis capabilities and reach over prior ESS and DSS applications. Incorporating the sustainability considerations, and the intended use of BIS across the stakeholder group, the model seeks to identify the capability of BIS to support both mental-model building and mental-model maintenance through organizational learning and contribute to sustained success for the organization through improved quality and perceptions of competitive performance.

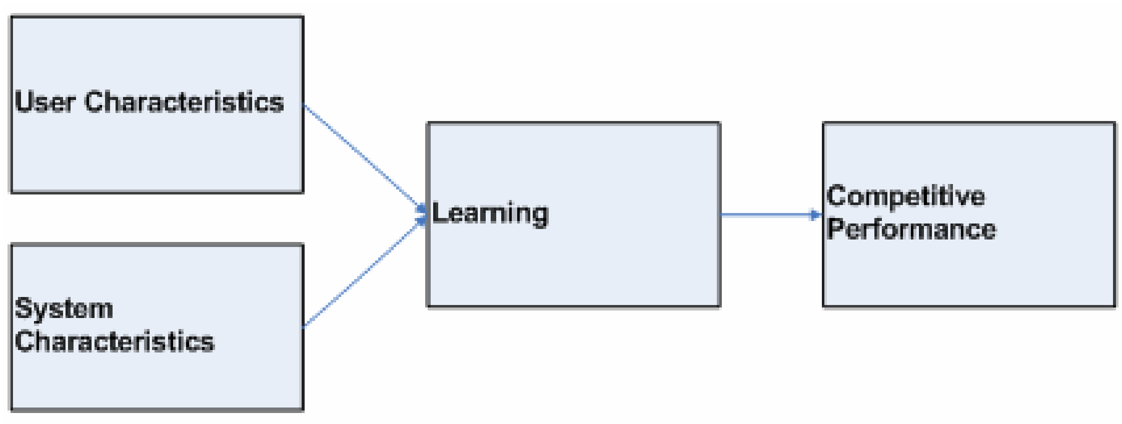


Figure 4: ESS Model

Ruiz et. al (2006) developed a model for technology, individual learning, and organizational learning. Organizational learning is a shared understanding which is increased through individual contributions of tacit and explicit information resulting from combinations of socialization, externalization. Research studies which apply information system design to support organizational learning are applicable to knowledge management. Organizational learning was found to be improved through information systems and individual learning, however organizational performance was found to be improved only through individual and organizational learning, but not information systems, such that performance can be improved vis-à-vis learning [75].

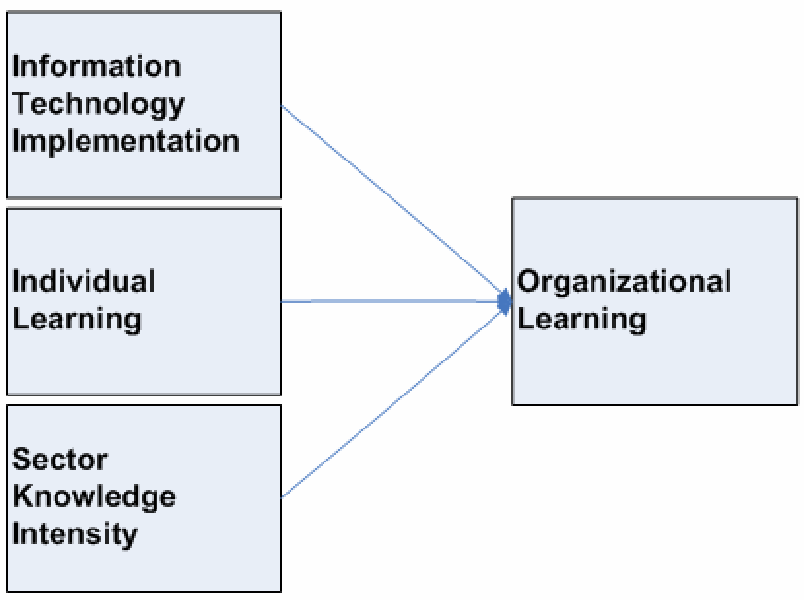


Figure 5: Learning Model

This study, similar to Kim (1993), considers organizational learning to be the integration of individual and team learning to the organization's systems, structures, strategies, procedures, culture, and environment adaptation. Several organizational learning theories are based on individual learning, however the link between individual and organizational learning must be explicit to avoid ignoring the role of the individual in organizational learning or over simplify the organizational complexity. An integrated model or organizational learning is proposed to address learning and shared mental models. Individual learning effects organizational learning through influences on the shared mental models of organization. An organization can only learn through individuals, but any one individual does not affect organizational learning. In the study organizational learning was comprised of the various learning levels and information flows contained within [45, 76].

In Chan et. al (2003) the organizational learning model explores linkages between individual learning and organizational learning. Organizational learning is often pursued to allow for adaptation to change, in response to failed management and planning, and seek to eliminate set behaviors or patterns [45]. Many researchers and studies identify learning at individual, team, and organizational levels in order to lead to improved performance. Skills, approaches, and commitment of individuals are transferred to collective team capabilities, and in turn leads to organizational learning. However, empirical evidence demonstrating these linkages is limited [45].

Organizations deploy BIS to aid decision making and competitive advantage. To achieve these advantages BIS should be integrated into managerial and operational processes, thereby leading to performance through business processes, and outperforming competitors. The business value of BIS can be defined and operationalized through business process performance, or operational efficiencies that are achieved through BIS, such as cost reduction and improved productivity, as well as value chain activities, which in turn influence organizational performance. Organizational performance is the aggregated BIS performance outcomes. This performance allows the firm to remain competitive in relation to others. Perception-based measures are used as some BIS benefits are intangible or qualitative, and many items are confidential and not readily available publicly. BIS has been shown to require customization to fit uniqueness of a firm, as well BIS may provide differing benefits based on organizational structure or industry [25].

During interviews with executives, managers, and professional staff, before, during, and after BIS implementation and from review of prior literature, information, system, service, and user factors were identified that may better explain learning within BIS. Users had also identified the separation between quality and performance outputs.

Quality was seen to encompass quality of healthcare review services, as well as the overall quality of the organization measured by stakeholder satisfaction metrics. Key to the customer satisfaction metrics were components of quality reviews, and surveys. Competitive performance was seen to take into account perceived ability to remain active in the marketplace and secure advantages. Based on the interview data, and prior models, a BIS learning model was developed. This model separates the systems component into service, system and information quality, as well as adds additional satisfaction and quality elements to measure a quality organization and competitive performance. The intent is to better explain the elements which influence learning models, and if learning, quality and competitive performance are dependent on individual, service, system, or information characteristics. In addition to exploring the resulting outcomes when utilizing BIS, a feature-rich architecture extended to a large stakeholder audience.

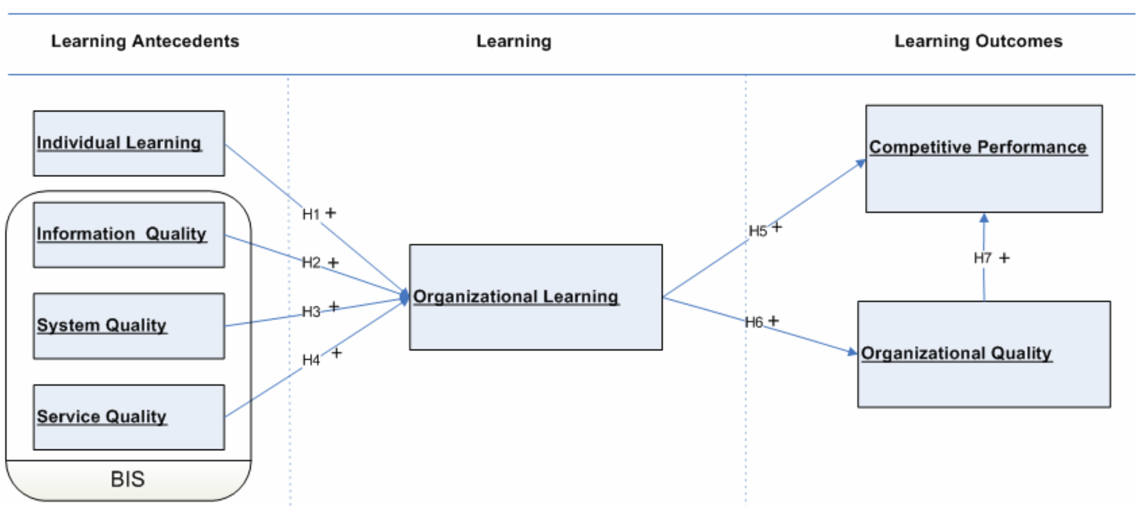


Figure 6: BIS Model

The model displays the impact of BIS on perceptions of quality and competitive performance when utilized to support organizational learning. Individual learning, information quality, system quality, and service quality are included as antecedents to learning in the model. Learning is an important factor in the quality and competitive success of the organization, in order to avoid failure and ensure continuous improvement and overall quality of life.

Figure 6 displays a path-analytic model with Individual learning, information quality, system quality, service quality, organizational learning, quality organization, and competitive performance as latent variables. A path-analytic model with latent variables is chosen to allow assessment of validity and determination of hypothetical constructs. The model also accounts for variable measurement error, to allow the underlying relationships to be measured rather than the individual manifest variable, by removing the error variance from the latent factor and modeling separately.

3.3 Hypothesis and Construct Definition

3.3.1 Individual Learning

H1: *There is a positive impact from individual learning on organizational learning*

Individual factors play a role in organizational learning, as it takes into account past experience, role and information system knowledge. Individual learning effects organizational learning through updating an organization's shared mental models, with organizational learning occurring through individuals [77]. Ruiz et. al (2006) studied individual learning and impact on organizational learning, and found a significant positive relationship, based on the ability for an individual to process information and create knowledge [75]. Yu (2009) describes individual learning as continuous improvement and changing cognition and behavior, with individual learning as a required condition for organizational learning [76]. In Chan (2003), individual learning was not significantly associated with organizational learning, and team learning partially related to organizational learning. Cross-functional team learning was significantly related to organizational learning, though considered similar to organizational learning [45].

Learning includes the two referenced mental models; mental-model maintenance, and mental-model building. Mental-model maintenance is when new information is incorporated into existing mental models and reinforcement occurs. Mental-model building is when mental models are modified based on the new information. Achievement of both mental-models is important to achieving quality and sustained competitive performance [18].

Within Social Cognitive Theory, viewing others interacting with a BIS, influences the observer perceptions of their own ability to perform the behavior, also known as self-efficacy. Self-efficacy can impact behaviors undertaken, efforts, and persistence to performance. Vandenbosch and Higgins (1995) studied self-efficacy, along with mental model maintenance and mental model building. Vandenbosch and Higgens (1995) proposed a model which describes the impact of ESS on competitive performance when learning is incorporated. The model includes two individual learning types, namely mental-model maintenance, and mental-model building. Mental-model maintenance is when new information is incorporated into existing mental models and reinforcement occurs. Mental-model building is when mental models are modified based on the new information. The survey research on executives show that competitive performance perceptions are found with regard to mental-model building, but not mental-model maintenance [18].

3.3.2 Information Quality

H2: *There is a positive impact from information quality on organizational learning*

Additional research has been targeted to quality of information systems output. Information quality refers to information that is accurate, complete, timely, and meaningful in format. Accuracy refers to correctness as measured by reference systems or experts. Timeliness is the delay time between input of information, and output of information to the end user for decision making. Currency is the overall age of the information and reflection of the current information state. Format is the layout design and display of the information output [74, 78].

King (2001) describes the information strategy for learning, which includes collection of data and transformation into useful and valuable information to support learning. The data may be numerical or textual information typically found in reports, as well as multimedia such as images or sound clips. The applications transform data into more meaningful information for decision making activities in pursuit of learning. Lucas and Nielson (1980) found that additional information did not necessarily result in greater learning, however users deprived of information exhibited lower levels or learning. The authors also found that information presentation, in particular with graphics and modes of presentation had an effect on greater learning. Vandenbosch and Higgens (1995) describe information quality as the most important attribute of ESS, and enabler of mental-model enhancement. Attributes of information quality were completeness, accuracy, timeliness, format, and relevance [18, 79, 80].

3.3.3 System Quality

H3: *There is a positive impact from system quality on organizational learning*

System quality includes the ease of system interaction and use, features and analysis capabilities, reliability or uptime/data consistency, architecture, and accessibility from various areas on-demand, and system factors are seen to promote learning and usage. Ease of use includes the system design and interface; the goal is that if the relative ease of use is high, users will be more inclined to learn the systems. Analysis capabilities include the features and technical characteristics, and have the ability to improve performance of the end-users. Architecture refers to the integration between system services and components. These items is important to learning, as it allows the user to more quickly make decisions and learn additional areas of importance based on system related quality [18, 74, 78].

Lucas and Nielson (1980) found support for system quality of terminal hardware in support of learning. Vandenbosch and Higgins (1995) described system quality in terms of reliability, ease of use, analysis capability and reliability. Analysis capability in particular was noted for enabling mental-model enhancement and learning. Significance found for ESS system quality in support of learning. Chen (2003) discusses that most traditional systems are not designed to support learning, and must be designed with capabilities and flexibility to capture and distribute knowledge to aid learning [18, 80, 81].

3.3.4 Service Quality

H4: *There is a positive impact from service quality on organizational learning*

DeLone and McLean (2003) add service quality as another measure of IS effectiveness. This is added in response to the changing IS roles of information provider and service provider, and the view of end-users as customers. This allows focusing not only on products but also services of IS area. Applied from marketing measures, the service quality dimensions include reliability, responsiveness, assurance and empathy. The measures apply regardless of whether the IS support occurs through an existing IS department, new unit, or external organization [49].

King (2001) discusses IS strategies to build a learning organization. IS traditionally reflects the management of information rather than learning, through IS employees add an important component to organizational learning. Typically after the infrastructure has been established, IS turns it over to users to go about using the system the way they see fit, and takes a passive approach to allowing individuals, groups, and the organization to learn as best suited. Some companies take a more active approach through motivating users to learn the software and systems, conduct training both formally and informally, and provide hands-on user support to enhance the learning outputs of the system and users [79].

3.3.5 Organizational Learning

H5: *There is a positive impact from organizational learning on competitive performance*

Mock (1971), describes increases in performance over initial decision periods, which can be attributed to learning. Additionally, differences in real-time vs. period information, were found not significant in terms of learning value of information systems between groups. In statistical decision theory, economic theory, and game theory, alternatives, states, outcomes, and probabilities are evaluated. However, in organizational environments, decision components are more ambiguous. Information value in economic terms, is when changes occur in events which aids decision making and payoffs. Ackoff (1957) describes useful information as informing in information economics [82, 83].

Vandenbosch and Higgins (1995) studied paths between learning and competitive performance. Mental model building was supported, whereas mental model maintenance was not supported, though different than anticipated with both forms of learning expected to influence performance. Janz and Prasarnphanich (2003) found support for work performance as a result of learning, in order to identify how knowledge and learning are gained and applied to generate organizational benefits. Lambert and Ouedraogo (2008) identified learning as significant factors in a firm's short-term and long-term performance. Learning helps solve current and urgent problems, thereby enabling short-term performance. Learning also enables short-term goal achievement, through continuous improvement of processes, work procedures and instructions, geared towards exploitation of existing information. Long-term performance requires a combination of existing information and new research and discovery, in order to understand complex systems and develop new theories, with appropriate systems and functions required to create and diffuse knowledge and information [18, 84, 85].

3.3.6 Quality Organization

H6: *There is a positive impact from organizational learning on being a quality organization*

A quality organization is an organization which has developed a set of behaviors to achieve stakeholder satisfaction. These stakeholders include internal employees, shareholders, and external clients or customers. The behaviors that underlie satisfaction include responsiveness to needs, information delivery, cooperation, program participation, incentives system, employee ownership, training and development [61]. Another component of a quality organization is quality of healthcare services delivery, with organizational variables of meeting review standards measured through audits, and timeliness of reviews measured through the system [52, 63].

Janz and Prasarnphanich (2003) found support for work satisfaction, a component of a quality organization, as a result of learning. Chang (2007) discusses learning aimed at increasing stakeholder satisfaction and quality of relationships, through learning customer needs and developing products or services to satisfy them. The study determined that there was a positive relationship between learning and quality. Ussahawanitchakit (2008) describes quality of services as an outcome of learning organizations. This refers to the gap between stakeholder expectations and perceptions [42, 46, 85].

3.3.7 Competitive Performance

H7: *There is a positive impact from being a quality organization on competitive performance*

Competitive performance is the ability to satisfy all stakeholders and hold a favorable position within a competitive segment. Measures include perceived parity with competitors, perceived advantage over competitors, profitability, revenue, and overall stakeholder satisfaction as measured through practices such as survey, interview, or complaint logging. Information systems can develop a competitive edge through lower costs, or enhanced differentiation [86].

Chang (2007) identified a relationship between quality and performance, and argue that quality is a determinant of and affects organizational performance. They study determined that there was a positive relationship between quality and performance. Ling-yee (2007) examined effects of relationship quality on performance, and found that improve relationship quality lead to improved performance. Ussahawanitchakit (2008) describes quality of services as a critical tool for achieving competitive performance, and a mediating variable between learning and performance. Organizations with higher quality of services have greater performance. Quality was found to have a positive relationship with performance [42, 46, 87].

Table 3. Summary of Supporting Works for Research Hypotheses

Hypothesis	**Supporting Works**
H1: Individual Learning -> Organizational Learning	Kim (1993), Chan (2003), Ruiz et al. (2006), Yu (2009)
H2: Information Quality -> Organizational Learning	Lucas and Nielson (1980), King (2001), Vandenbosch and Higgens (1995)
H3: System Quality -> Organizational Learning	Lucas and Nielson (1980), Chen (2003), Vandenbosch and Higgens (1995)
H4: Service Quality -> Organizational Learning	King (2001)
H5: Organizational Learning -> Competitive Performance	Lambert and Ouedraogo (2008), Janz (2003), Vandenbosch and Higgens (1995)
H6: Organizational Learning -> Quality	Chang (2007), Janz (2003), Ussahawanitchakit (2008)
H7: Quality -> Competitive Performance	Chang (2007), Ling-yee (2007), Ussahawanitchakit (2008)

3.4 Methods

This research study utilizes qualitative and quantitative methods of analysis using a survey instrument and case study for primary data collection. Reliance on one method can create issues, for example qualitative research lacks rigid control, while quantitative methods may create pre-determined certainties. Many authors recommend both qualitative and quantitative methods to add context to research, offer an expanded view of the topics, and allow validation of findings through more than one methodology [21, 88]. The survey instrument analyzes the research model using formalized methodology, the case study includes interviews and system information and results. The survey includes a control group, which due to security and location restrictions, had access to the BIS only through a single shared computer. The primary study group had individual computer connectivity to the BIS for improved accessibility and information visibility. The qualitative and quantitative analysis results were triangulated to form discussion points and conclusion outputs. A summary of control and study group BIS components are shown below.

Table 4. Control and Study Group BIS Components

BIS Component	Control Group	Study Group
Knowledge Management	-	Advanced
Content Management	-	Advanced
Performance Management	-	Advanced
End-User Tools	Basic	Advanced
Querying / Reporting	Basic	Advanced
Analysis	Basic	Advanced
Database Management System	Basic	Advanced

3.5 Instruments

A survey was development followed Moore and Benbasat's (1991) identified stages of item creation, scale development, and testing: Item creation, in which existing items were utilized from prior literature, then additional items added to those components which fit the definitions. Scale development, where similar categories of items were created and refined as needed. Testing, in which sample surveys were conducted, and then was followed by revisions and larger distribution [89]. A full copy of the survey instrument is included in the Appendix. The final survey is randomized to reduce order effects. Additional information is collected from non-survey sources such as system, case study, and interview information. The survey consists of user characteristic questions such as location, tenure, and position/level, followed by individual items to measure the remaining constructs. The survey uses a seven point likert scale, and measures the level of agreement with each statement, with 1 being strong disagreement and 7 strong agreement. The survey was reviewed by colleagues in and across organizational levels as part of a pre-test to resolve any concerns or address any identified discrepancies, as well as re-word identified items, or remove non-weighting or duplicative manifest variables. The study sample includes BIS active user respondents, and includes employees across various levels of the organization.

A case study is also used to assist with development, testing, and explanation of the conceptual model, following methodologies outlined by Eisenhardt (1989) and Dube and Pare (2003). Qualitative research methods to study IS phenomena is growing, with case study research as an accepted method in the IS field. Case research is fitting, as information systems as a component of organizational issues are studied. Access to real-life experiences allows both academic and practitioner feedback, increased understanding of the complex interactions between organizations, technologies, and people are developed. A case study approach allows new ideas, opportunities, challenges, and issues to be identified, and can be used for hypothesis generation, explanation, and testing. All of these items allow for improved knowledge generation and contribution within the IS field [88, 90].

IV. CASE STUDY ANALYSIS AND RESULTS

4.1 Organizational background

A national quality improvement and care management company whose solutions focus on improving health outcomes while reducing health care administrative costs for commercial and public clients. URAC accredited in utilization health management and case management, with six offices across the county in Harrisburg, Tampa, Baltimore, Cleveland, Nashville, and Richmond, with employment of 300 physicians, nurses, social workers, case managers, information technologists, analysts, and communications and administrative professionals, and access to a physician review panel of over 3,200, including representation for all major subspecialties. Clients include Medicaid, state programs, federal agencies, employers, the Department of Defense, managed care organizations, providers, large commercial health plans, and third party administrators. The organization has assessed health care in some capacity for approximately 17 million lives in both the public and commercial marketplaces.

4.2 BIS Overview

The organization identified HIT as a critical component to a quality organization and designated a HIT Quality Project to enable Business Intelligence and Performance Management capabilities to meet and exceed stakeholder requirements and improve organizational quality. The organizational solutions focus on improving health outcomes while reducing health care administrative costs for commercial and public clients, requiring the need for advanced HIT capabilities to analyze the various stakeholder requirements and relationships.

The Business Intelligence (BI) Initiative, which officially began in late 2007, with BIS feature rollout occurring through 2009, addressed organizational requirements for a scalable, feature rich, and value added technology architecture (platform) to support current and long-term requirements for data, information and intelligence. The development and deployment of a comprehensive BIS represented a critical, strategic need that would be aligned with business and medical initiatives. Among the initiatives scope and objectives were:

- Provide a scalable enterprise BIS
- The physical location of data is transparent to end users
- Data is easily accessible, accurate, consistent and high quality
- Provide a standard reporting and analysis toolkit
- The BIS is accessible through single point of entry (portal)
- The BIS provides advanced decision support, analytics, informatics and data mining

- The BIS enables enterprise wide performance management
- The BIS generates a sustained competitive advantage

4.3 BIS Initiative Team

The Business Intelligence (BI) Initiative also sought to identify key roles and responsibilities, to ensure successful deployment and objective achievement. Having a dedicated set of resources with clearly described areas of focus was seen as an important component of the initiative. The resources may occupy more than one role at a given time, however having full-time availability is commonly found as a critical factor in prior BI projects [4]. The key roles and descriptions identified as part of the initiative are listed below.

Table 5: BIS Team Roles

Role Title	Role Description
Sponsors	- Primary driver of new requirements - Business need for data - Provides budget support - Provides political support - Ensures resource availability - Champion and promoter of Initiative
Initiative Manager	- Defines, plans, schedules Initiative deliverables - Assigns tasks and monitors completion - Develops Initiative charter and comprehensive delivery document - Measure costs and benefits - Resource planning - Measures success metrics - Compiles and communicates status
Information Technology Planning Council (ITPC)	- Makes critical decisions - Authorizes resources - Determines priorities - Approves platform - Approve objectives and measures of success - Reviews major milestones and deliverables

Subject Matter Expert (SME)	- Business area experts - Establishes true data definitions - Determines what data is needed - Determines data format - Determines level of detail or summary - Identifies what security or authorization access is needed for the data - Monitors quality - Determines requirements - Sets priorities - Determines historical data needs - Documents business definitions - Owns data - Identifies data sources - Determines needed system availability - Writes test cases - Identifies transform rules - Defines cleaning rules
Business Analyst	- Knowledge of business processes and data - Captures requirements - Identifies possibilities and improvements - Facilitates discussions between groups of users - Identifies future business needs and opportunities - Full cycle preparation of queries and reports - Monitors data - Understands data meaning, timeliness, and sources
Data Administrator / Modeler	- Models the data according to business rules and policies - Documents and maintains the mapping between logical data model, the physical database design and the source data and data warehouse - Develops naming standards - Utilizes ETL/CASE tools
Data architect	- Develops architecture of tools and interfaces - Determines best method for integrating data sources - Develops data standards and procedures - Defines ETL process - Defines testing procedures
Application Developer	- Back-end ETL process - Utilizes ETL/CASE tools - Tie-outs (extracted records match loaded records, error handling, error definition) - Front-end delivery applications - ETL data cleansing
Security Architect	- Determines access control - Develops security policies and procedures - Identifies data security and level of granularity - Determines capabilities and approach to establishing security - Identifies of security issues and resolution - Determines system integration security
Database Administrator	- Develops physical design - Database performance - Backup and recovery - Tuning and optimization (indexes, summaries) - Monitors query performance and improve systems or provide recommendation to users - ETL performance - Capacity planning (size, cpu, disk speed).

Technical Services Architect	- Long term plans for disaster recovery - Hardware installation, maintenance, and support - Software installation, maintenance, licensing, and support - Network installation, maintenance, and support - Monitors system performance and improve systems or provide - recommendation to users
Data Quality Specialist	- Locates and reports data quality issues - Incorporates issues into logical data model - Determines priority for quality fixes - Develops queries/reports to identify issues - Develops recommendations for ETL process
Content Administrator	- Content management site setup and implementation - Content management updates and maintenance - Assists with interface issues - Monitors and reports site performance, site analytics - Develops and maintains metadata repository - Develops dynamic online BI capabilities - Setup of online security and access - Documents layout - Documents tool security and access - Documents test plan - Creates content templates
Metadata Administrator	- Creates metadata templates - Develops format / naming conventions - Documents business metadata - Documents technical metadata - Defines and designs metadata repository - Administers the metadata repository – updates, inserts, deletes
Educator	- Becomes knowledge expert on platform functionality through self-study and outside training - Develops training program and tailors to varying groups of users - Holds just in time training as part of system deployment - Holds ongoing training sessions for new and existing users - Develops user-relevant sample data as part of training - Evaluates and improves training - Supports user inquiries and learning

4.4 BIS Risks

A formal set of risk components were identified early in the BIS initiative, in order to mitigate major issues or failures.

Table 6: BIS Risks

Item	Mitigation Steps / Notes
Source data quality	Requires data cleanup identification Data cleansing routines Data quality prioritization Operational improvements

Requisite skill set / Number of new technologies	Identify training needs Provide initial training Provide ongoing training and support Build on existing skill set Phase where possible Enable additional training time
Resource availability	Fill open staff positions Fill resource gaps Ensure dedicated resources
User acceptance / expectations	Enable additional training time Include end users in each Initiative aspect Enable prototyping Support workflow redesign
Initiative plan	Develop detailed Initiative plan Revise and update detailed Initiative plan on periodic basis Limit scope creep Define change management process
Performance	Very Large Database (VLDB) > 500GB Performance test functions
Vendor support	Ensure external vendor support agreement Internal training and support Establish service level agreements (SLAs)
Geographic environment	Ensure periodic communication between areas Centralize administration and design
Financial	Establish ROI metrics Establish methods for cost-benefit analysis Utilize proven technologies
Software upgrade paths	Vendor BI software upgrade timelines / functionality Organizational software upgrade timelines / functionality Review, revise and update periodically to assess impacts

4.5 BIS Communication Standards

The following identifies the forums for communicating Initiative status:

Table 7: BIS Communication Standards

Title	Frequency	Description	Participants
Working Sessions	Daily	Individual task assignments and meeting discussions.	All (as needed)
Status Sessions	Weekly	Discuss individual status of activities, deliverables, problems, and solutions. Review Initiative status. Weekly time box activity review.	All
ELT Update	Weekly	Review Initiative status.	Initiative Sponsors
ITPC Review	Monthly	Review Initiative status.	ITPC committee
Users Group	Monthly	Discuss issue logs, change control, questions & answers, knowledge base.	All

Newsletter	Quarterly	Share experiences, success stories, tips and tricks, organizational content.	All

4.6 BIS Problem Statement

The existing systems and data repository environments were at times unable to provide complete, accurate, integrated, and timely information. Critical information was often contained in disparate locations, with numerous tools and techniques required for transforming the data. Conflicting results, time to obtain results, accuracy, and consistency were some of the challenges experienced by those involved in the data and information delivery process.

4.7 BIS Purpose

Internal and external data requirements necessitated a capable BIS; and were identified as factors in securing current contracts and future business opportunities. In the context of a highly competitive business landscape, it is imperative that the BIS easily provide information and data deliverables, and support value added services. Key performance management capabilities included in a BIS were reporting, analysis, data mining, informatics, KPI/scorecards, modeling, knowledge management, content management, and data warehousing.

4.8 BIS Features and Architecture

The BIS was rolled-out in releases, with each release comprising a series of iterations. This was intended to speed deployment of the system and feature set available to the end users and allow for parallel development of releases by varying resources. The set of BIS features contained a comprehensive set of capabilities which enabled advanced information access and decision making. The first release contained setup and implementation of the data warehouse and associated infrastructure. The second release included building the ETL functions to store the required data from operational systems within the data warehouse. Once the basic tenets of the warehouse and data were loaded, subsequent phases could begin, including portal setup which contained content management, knowledge management, and search features. Followed by reporting, analysis, and performance management features added to the overall platform. The initial infrastructure including hardware and software installation which resulted in a skeleton platform with limited functionality was prepared, and over the following year iterations were conducted roughly every month to add system value and capabilities.

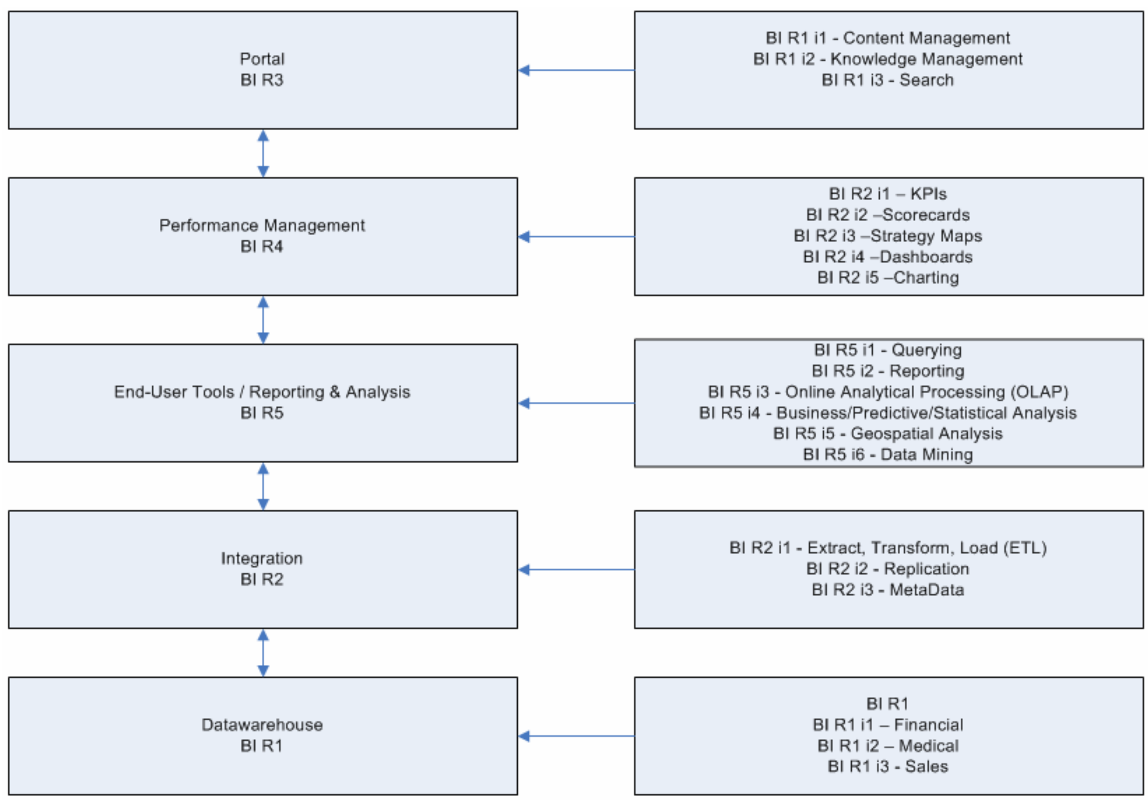


Figure 7: BIS Features and Architecture Releases and Iterations

4.9 BIS System Quality

Prior to the BIS, most data was manually tracked via spreadsheets and stored in multiple database locations, making accessibility and easy use of multiple sources more difficult, in addition no systematic capabilities existed to automatically aggregate and perform analysis. As a result of BIS, system quality improvements were evident along with improved accessibility and ease of use, as one quality manager commented on KPI entry and scorecards accessibility:

> I have received excellent feedback regarding the ease of the data entry and access.

Prior to the BIS, some system reliability issues and downtime existed, in addition performance was degraded at times of high usage. The BIS resulted in improved reliability, experiencing no unplanned outages during its term in operation, in addition, average system response time, a key measure of system performance, was substantially below the established threshold, and has remained low despite increased usage. It is expected that improved capabilities and performance allow the user to more quickly access information to make decisions which aid learning. A medical professional described the improved accessibility and technical capabilities of the BIS:

> There is quicker and easier access to databases, time collection, employees, and benefits; it's like a one stop resource library.

4.10 BIS Information Quality

Information quality was seen as a key contributor to learning and associated quality and performance. The BIS improved information quality through a standardized set of data, housed in a centralized data warehouse, allowing for a single-source of truth. Approximately 1000 Key Performance Indicators were also tracked within the centralized data warehouse, allowing information monitoring of critical items across financial, operational, and employee areas. All information was presented through a centralized web site, in a common format with a similar look and feel across data sources and sub-sites. The centralization of information was a key component based on feedback of one sales professional:

> I like that all of the company's information is housed in a central location. It saves time from having to email a lot of documents multiple times. I also like that everyone has a general idea of where to find things that they need.

User requirements were solicited to gauge outputs, and several user-groups were setup to capture feedback on information outputs to allow improvements. Where possible, information was made real-time, with at most 24 hour load periods. As one sales manager commented on the departmental dashboard and information presentation:

> This is one of the cleanest dashboards that I have seen. It tells us what we need to know... Nice. Simple.

Information quality was also identified for enlisting additional capabilities, and further extending information sharing and information content across the organization. As a set of managers commented:

> I would like to see more information sharing.

> As a frequent user I value the ease of finding and sharing information. However, I have found that many are currently not utilizing the BIS to its fullest potential.

Information quality is expected to improve decision making and learning, as users are able to identify required information more quickly and easily than before. Information has been codified through knowledge base capabilities, such as document folders, wikis, discussion boards, and self-service reporting capabilities. When the vision of information quality was discussed early on prior to BIS, one executive described capabilities now available under the BIS:

> Going to one site, with roll-up of data in various areas, then drilling down to various sites, with reports, and key measures on a dashboard.

4.11 BIS Service Quality

As new information systems typically require large dedicated staff and user support, service quality was also seen to lead to organizational learning through improved IS support of end-users and responsiveness to needs. As one medical director mentioned:

> The staff is available polite and extremely helpful. The BIS support areas demonstrate an unique ability to transform information into a useful format that can be easily understood

It is also suggested that through the knowledge and support of end-users, contribution to their learning would occur through improved understanding and knowledge of the overall BIS system. As one operations manager stated:

> I have always received courteous and complete responses to any BIS questions I have posed. The staff is knowledgeable and efficient.

4.12 Individual Learning

As with previous information system studies and implementations, user learning were suspected to influence organizational learning with regard to BIS. When asked which characteristics were seen to influence individual learning, users commented to to the process or task characteristics. As one information technology manger described:

> Our department required that all information must be published to the BIS and we changed our habits accordingly.

4.13 Organizational Learning

Prior to the BIS, several users commented on the ability to move from a static reporting system to a more dynamic system which allowed for improved decision making support, as one executive stated:

> I need more analysis and less reports. I wish they would provide me with some recommendations with more data mining, trending of information and proactive analysis would be helpful.

It was anticipated that users would require time to adjust to the BIS, and incorporate the capabilities into their daily routines, but over time individual and organizational learning would occur, as one Medical Director commented during early implementation of BIS:

> Right now I am on a learning curve, with time, as I get used to using the system, I expect I will value it more.

Users also supported the notion of democratization, where information is accessible to all levels of the organization, as one Sales Manager recommended:

> Continue pushing decision making and authority down into the organization so that knowledge and available resources is not limited to one or two people.

As a component of the BIS, dashboards were setup to aid in the monitoring of various key indicators, one of the dashboards contained metrics relating to service desk activity, these were seen as a capability to improve insights and develop support of mental model building, as one IT executive described:

> Based on the primer you provided me today, I now have full appreciation for the monitoring capabilities provided through the BIS for Service Management. These stats will provide me with invaluable insight into the operation of our Service Desk call center.

The BIS was also seen to improve organizational understanding to aid learning, and mental model maintenance, as one operations professional responded:

> The BIS has helped us to better understand the organization overall, and the various aspects of the business that we may not have had a clear picture of previously.

4.14 Quality Organization

When users were asked to explain a quality organization, they identified improved customer satisfaction, healthcare quality, and stakeholder needs, this was also referred to in the developed mission statement of the organization:

> To advance the quality and efficiency of healthcare through integrated care management solutions tailored to the needs of our customers and stakeholders.

To build quality programs and ensure exceptional customer service to their clients, service and process performance measures were developed and implemented throughout all aspects and levels of the organization. These performance measures are tracked and improved utilizing the BIS capabilities. The Quality Measures addressed the following core areas of Shareholder, Customer, and Employee satisfaction. As one executive described each core area:

> Shareholder Satisfaction: Our ability to deliver on the shareholders' expectation of both growth and profit with corresponding measures which reflect the shareholder's requirements.

> Customer Satisfaction: Our ability to deliver a quality product to the client is essential to sustaining the organization. We will expand our definition of quality to include clinical, financial, and satisfaction outcomes for our clients.

> Employee Satisfaction: Employees are the cornerstone to the organization. Our ability to create and sustain a high performing organization of responsibility, accountability, and recognition is paramount to our success.

In addition to quality review measurements, other quality improvement projects were initiated to improve quality throughout the organization. During periodic measurement and feedback, one operations manager commented:

> The quality of the support departments have continually improved, even though the resources are limited.

4.15 Competitive Performance

Performance was seen to increase as a result of organizational learning through use of BIS, and this was evidenced from user comments. As one medical professional stated:

> Being a fairly new employee I am still learning about the BIS however, I am convinced that the more I learn about the BIS it will enhance my performance.

The productivity impact of BIS outputs were also seen, which were identified as a key component of competitive performance, as operations manager stated:

> The tools and reports the BIS ITS staff develop are very helpful to me in doing my job.

When asked what value might BIS and learning deliver, one executive identified the capability to more quickly react to changing business conditions, which would lead to improved performance. Users also identified new requirements for increasing information and capabilities of the BIS, including more dynamic capabilities for utilizing information to aid learning, quality improvements, and performance.

4.16 CASE STUDY – Quality Organization

The organization designated a HIT Quality Project to enable business intelligence and performance management capabilities to meet and exceed stakeholder requirements and improve organizational quality. The project solutions required a focus on improving health outcomes while reducing health care administrative costs for clients, requiring the need for advanced BIS capabilities to analyze the various stakeholder requirements and relationships. These Quality Measures addressed the core areas of customer, employee, and shareholder satisfaction, and were developed, tracked, and improved utilizing HIT capabilities. The BIS quality improvement outputs include a Quality Quadrant, Quality Matrix, and Quality Model, and are described in further detail below.

IT projects have historically been measured solely on timeline and budget targets. Within Healthcare, IT projects are increasingly requiring quality impacts as the basis for measurement and value. The BIS capabilities and processes allow for individual organizations to focus specifically on those areas which have the greatest impact on organizational quality. Improved quality results are demonstrated following the proposed process framework, leading to organizational quality as measured through varying stakeholders. As healthcare organizations seek to continually improve overall quality and adopt new capabilities, quality project management plays a critical role in providing the capabilities and streamlined access to summarized information utilized for decision making.

4.16.1 Quality Quadrant

Within a given organization, there is often significant variability at a business unit level. In past studies, units that score above the median on employee and customer satisfaction measures were found to be 3.4 times more effective financially as measured by total revenue, performance targets, and year over year gain in sales and revenue.   If the focus is on employees only, the business unit may be too inwardly focuses. If the focus is on customers only, employee satisfaction will erode over time. Unchecked quality of the customer and employee experience can create issues. Often this variability goes unnoticed or unmanaged, and revenues and profits are bled off and growth is stagnant. In many organizations, the objective of achieving a unified corporate culture and brand goes unrealized. Performance must be continuously improved, and feedback given at the lowest level of variability and specificity [91].

Employees are able to affect profitability two ways. The first is direct cost, where committed employees are more productive and produce better quality levels leading to profitability. The second is indirect customer results, where strong employees generate strong customer connections, leading to customer retention, profit, and growth. Despite this, one study identified that only 29% of employees were energized and committed to their work, with 54% doing only the required tasks, and the rest disengaged. Within IT, the situation may be even worse, as another recent study suggested that in 2009 only 4% of IT employees were highly engaged. Those organizations with high employee satisfaction are more productive, profitable, and have lower turnover. These employees also better serve their customers. Performance indicators which utilize both customer and employee areas provide stronger links to financial and operational results [91, 92].

To address the variability between organizational sub-units, responsibility must be centralized, and managed at a total organization level. However data is often contained in multiple disparate locations. For example customer data may be held within the marketing or quality department, employee data held within human resources, and financial data within finance. These sources must all be combined on a single platform to understand the health of employee/customer relationship [91]. This information integration can be achieved utilizing HIT, and presented in a consolidated view to the appropriate stakeholder and at the appropriate level of specificity for decision making purposes.

To determine the existing business unit's variability and combine comparative sub-unit data across the organization, a Quality Quadrant shown in Figure 8 was developed to identify the key areas of focus and improvement for each individual business unit and from an organizational perspective. This concept is similar to various industry quadrants ranking software providers, services, etc. The quality quadrant displays the relative quartile for customer and employee satisfaction, within either the higher or lower quadrant combinations. The employee and customer satisfaction data was collected throughout the year at various points in time and plotted along the respective axis, and within the relative quadrant. The objective for each sub-unit was to increase the appropriate area of improvement employee or customer improvement accordingly. The objective for the overall organization, was to simultaneously increase both customer and employee satisfaction, while reducing variability between contracts to form an improved and unified quality organization over time.

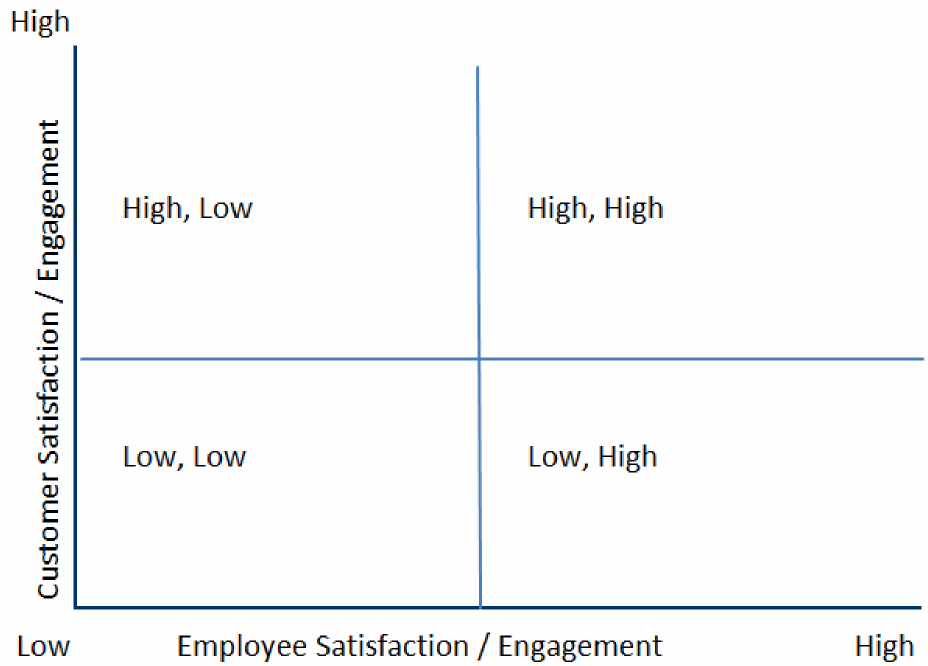


Figure 8: Quality Quadrant

4.16.2 Quality Correlation Matrix

Correlation analysis, a Six Sigma technique is utilized to identify relationship between measures. The process links the individual measures to the appropriate category. This method allows the reduction of potentially hundreds or thousands of measures into a meaningful and manageable subset. The correlation also identifies the directional relationship, with the direction indicating a positive or negative relationship. This correlation analysis can be performed using commonly available statistical software packages [93].

The Quality Correlation Matrix shown in Figure 9, describes the relationship between Customer, Employee, and Shareholder metrics. For emphasis, metrics with significant positive relationships can be displayed in green, significant negative relationships can be displayed in red, all others left blank. The objective is active improvement of identified measures which have the greatest impact to the resulting stakeholder. For example, if an organizational sub-unit found that that employee satisfaction was listed within a low quadrant, they would utilize the correlation matrix to identify that involuntary turnover rate has a negative relationship to employee satisfaction, and seek ways to either reduce involuntary turnover, or formulated methods to minimize the impacts. The HIT output gives improved insight and perspective when developing quality management initiatives.

		Customer Satisfaction	Employee Satisfaction	Shareholder Satisfaction
Customer Satisfaction	ROI	🟢	🔴	🟢
	Survey Results	🟢		
Employee Satisfaction	Voluntary turnover rate	🔴		
	Involuntary turnover rate		🔴	
Shareholder Satisfaction	Revenue	🟢		🟢
	Profit			🟢

Figure 9: Quality Correlation Matrix

4.16.3 Quality Model

Within service industries, significant focus has been placed on employee satisfaction and the link to customer satisfaction. Satisfied employees leads to satisfied customers through improved service experiences and the value and outstanding service offered to them by employees. In time, this is expected to lead to increased market share and profitability for the firm. Based on the promise of increased sales and financial returns, service companies often invest heavily in employee and customer satisfaction. However many studies find various relationships, with satisfied customers not always guaranteeing success [94].

As a company's intangible assets reside in employee’s knowledge, employee retention has been another key focus. Reducing turnover is expected to be linked with satisfaction, and reduced costs of replacing employees, and improved customer service. Findings between employees, customers and financial performance have received mixed findings. Some studies have suggested positive relationships, while other studies suggested that sometimes customer satisfaction is reflected in profits. Others suggest that in the short-term financial results may be influenced by many factors, but in the long run will be positive as a result of customer satisfaction. Employee satisfaction may occur through pay, ongoing training, and employee security. Some studies haven't yielded a significant relationship between employee satisfaction, while other reported a negative relationship. Most studies find that employee and customer satisfaction have a positive relationship [94].

The Quality Model, shown in Figure 10, displays directional relationships between employee, shareholder, and customer satisfaction. These relationships often vary by firm, and may contain significant positive relationships, significant negative relationships, or no significant relationship at all. These relationships may also change over time, and throughout the course of a firm’s progression. The objective is to develop strategic plans which balance all stakeholder requirements, and set goals which align with identified impact factors.

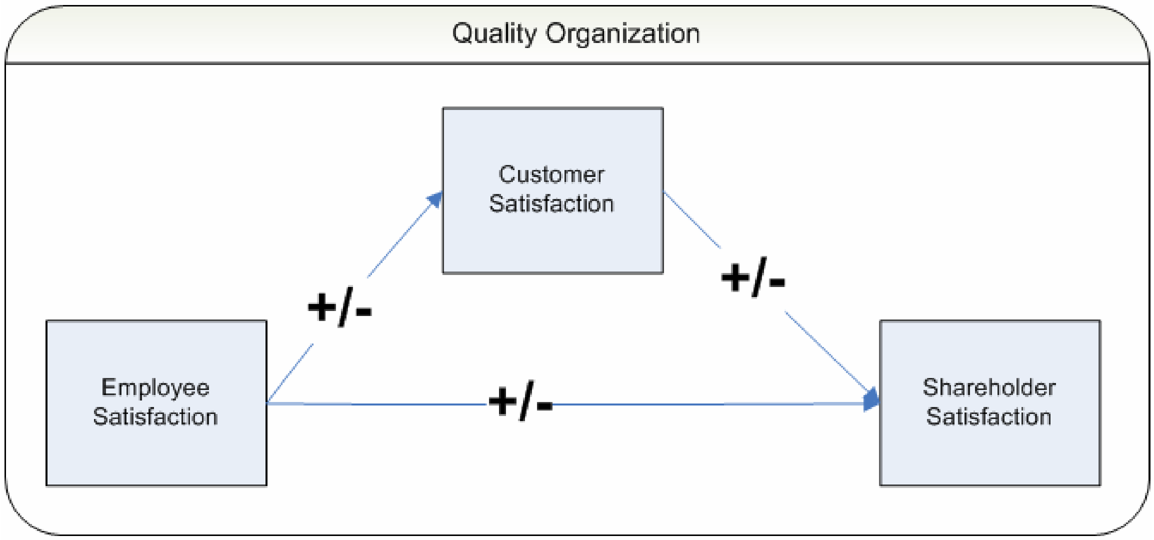


Figure 10: Quality Model

Table 8: Quality Model Hypotheses / Constructs

Item	**Supporting Works**
Employee -> Shareholder	Bernhardt (2000); Chi, Gursoy (2009)
Employee -> Customer	Bernhardt (2000); Yee (2008); Chi, Gursoy (2009)
Customer -> Shareholder	Bernhardt (2000); Yee (2008); Chi, Gursoy (2009)
Shareholder: Profit	Yee (2008); Chi, Gursoy (2009)
Shareholder: Revenue	Yee (2008); Chi, Gursoy (2009)
Customer: ROI	Yee (2008); Chi, Gursoy (2009)
Customer: Survey	Yee (2008); Chi, Gursoy (2009)
Employee: Voluntary Turnover	Hurley (2007); Chi, Gursoy (2009)
Employee: Involuntary Turnover	Hurley (2007); Chi, Gursoy (2009)

4.16.4 Quality Results

The results are presented in the form of relative improvement, or the absolute improvement divided by the difference in baseline performance and ideal performance [95]. The results model displayed in Figure 11, displays the top two measures which have the greatest impact to resulting customer, employee, and shareholder satisfaction as measured by a correlation coefficient. Statistical analysis is able to be conducted, with analyzed paths between employee and customer, employee and shareholder, and customer and shareholder to determine statistical significance. All measures were conducted throughout 2009 to develop baseline measurements, improvement targets, and final year end actual values. Return on Investment (ROI) and customer survey results were identified as primary indicators and improvement of customer satisfaction. Customer ROI showed a relative improvement of 25% and the customer survey which measures overall satisfaction showed relative improvement of 15%. Involuntary and voluntary turnover were utilized as indicators of employee satisfaction. Involuntary turnover showed a relative improvement of 13%. Voluntary turnover showed a relative improvement of 8%. Revenue and profit were utilized as indicators for shareholder satisfaction. Revenue showed a relative improvement of 2%. Profit showed a relative improvement of 4%. The results demonstrate that through a formalized HIT process framework, significant improvement of organizational quality is able to be realized.

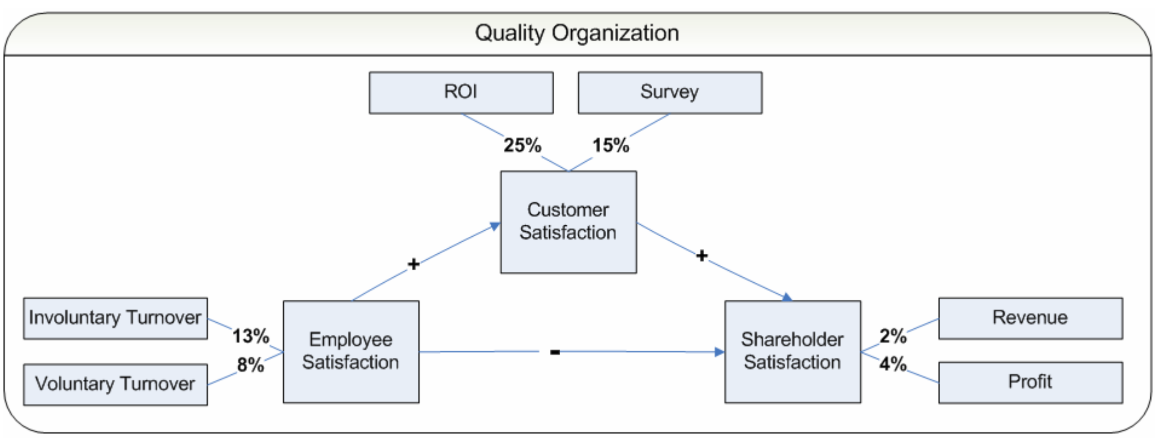


Figure 11: Quality Organization Relative Improvements

4.17 CASE STUDY – Physician Healthcare Services Review

4.17.1 Overview

The Chief Medical Officer commissioned a project to explore the physician components of healthcare services review. Among the current management issues and challenges were monitoring of physician activity, productivity metrics, and additional insights. Overall project objectives included reduce overall physician costs and having consistent comparison benchmarks.

4.17.2 Physician Activity Monitoring

Monitoring reports and dashboards were developed to improve information and system quality of physician data. Reports and dashboards were available via a self-service system, and reviewed by the medical directors and physicians. Full copies were reviewed by the area medical directors, while de-identified copies were made available to the individual physicians for comparison. This allowed comparative assessment of performance across the staff continuum. A second component also allowed the users to view case mix by type, and drill down to view the exact cases that were reviewed during the specified time frame. Reviews were also audited by a quality control team in an effort to improve overall quality of the reviews and provide improvement feedback over time.

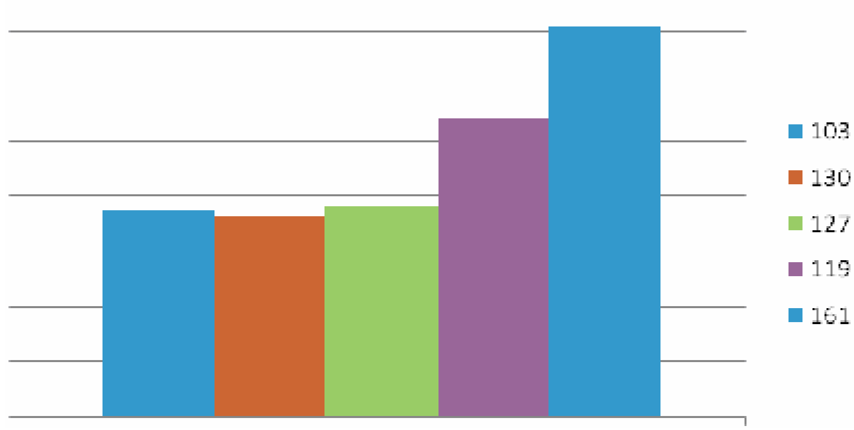


Figure 12: Relative Physician Productivity – Cases Per Hour

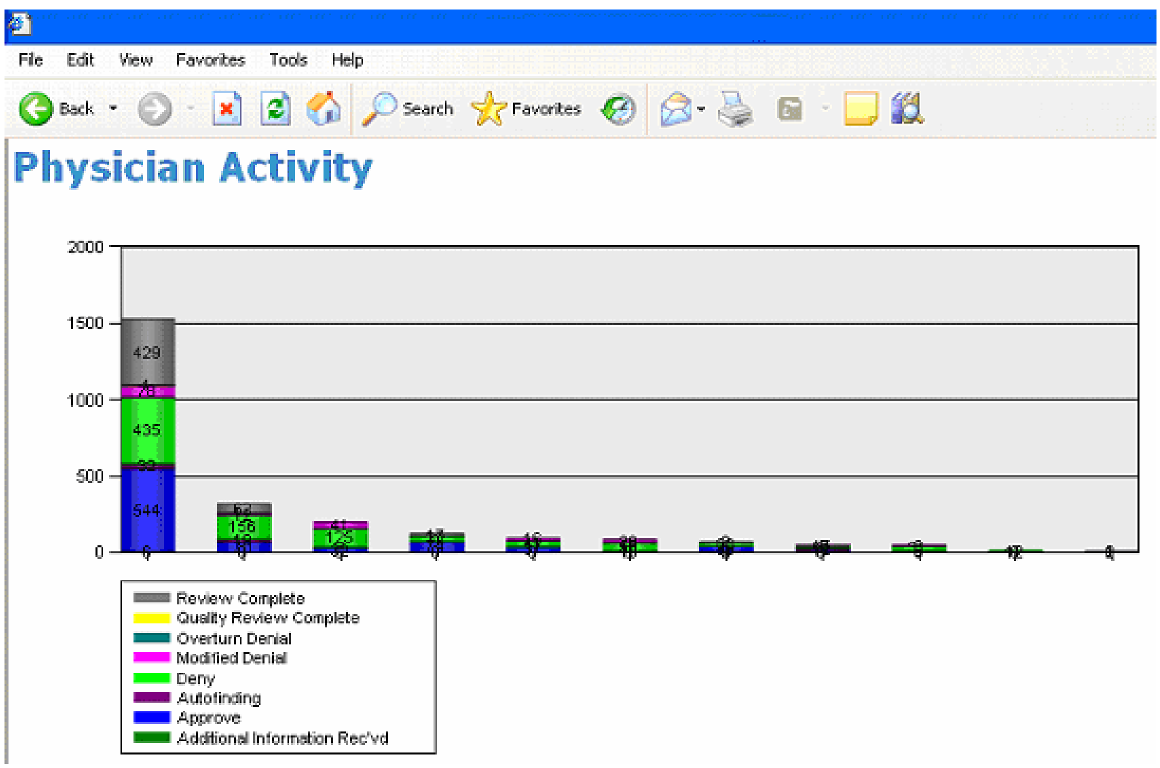


Figure 13: Physician Activity – Activity Types

4.17.3 Physician Review Results

Results for improvement were substantial, in one contract area during a year over year comparative, productivity, as measured in cases per hour increased 32.6%, and cost per case decreased by 12.4% year over year. The difference in percentages between productivity and costs, has to do in part with a set of fixed costs for permanent physician positions vs. temporary physician positions, as more cases were able to be completed by the fixed cost positions. In another contract area, relative productivity improvements resulted in over $250,000 in savings over baseline period, and increasing productivity quarter over quarter, while maintaining overall quality levels.

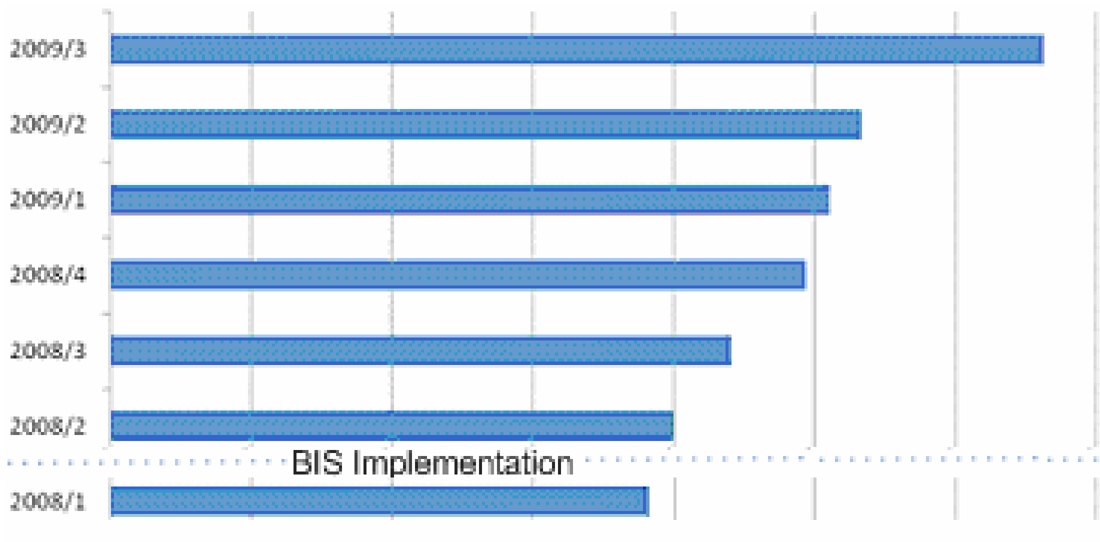


Figure 14: Physician Productivity Improvements – Cases Per Hour

4.18 CASE STUDY – ITS Service Management

4.18.1 Service Management

The Vice President and Manager of Service Management and IT requested a capability for improved service management capabilities as part of the BIS. This included the ability to monitor service desk incidents against key metrics, along with monitoring systems performance. Additionally another key area was in automation of end-user reporting either through automation or self-service capabilities. The items operationlized included a scorecard component, a set of dashboards, and online reporting suite.

4.18.2

Service Management Monitoring

The ITS scorecard included the following components: call center metrics including call volume, time to answer, and abandonment rates, incidents submitted by site, incidents submitted by source, total incidents, completed incidents by priority, completed incidents by type, and turnaround time by priority. These items were tracked as actual values, and against established targets. The scorecard was drillable, to allow viewing more granular detail under each KPI category. A set of system dashboards allowed real-time monitoring of CPU usage, logical I/O usage, along with activity details such as login attempts, query generation, and system logging.

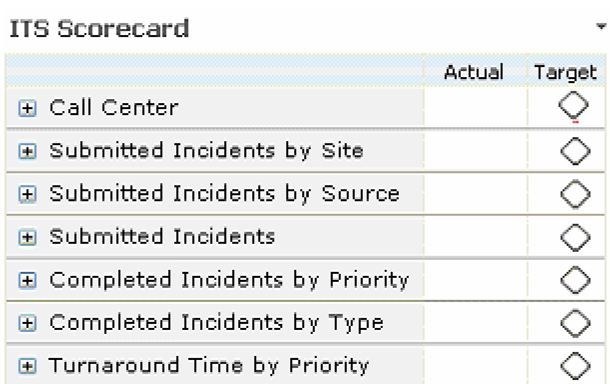


Figure 15: ITS Scorecard

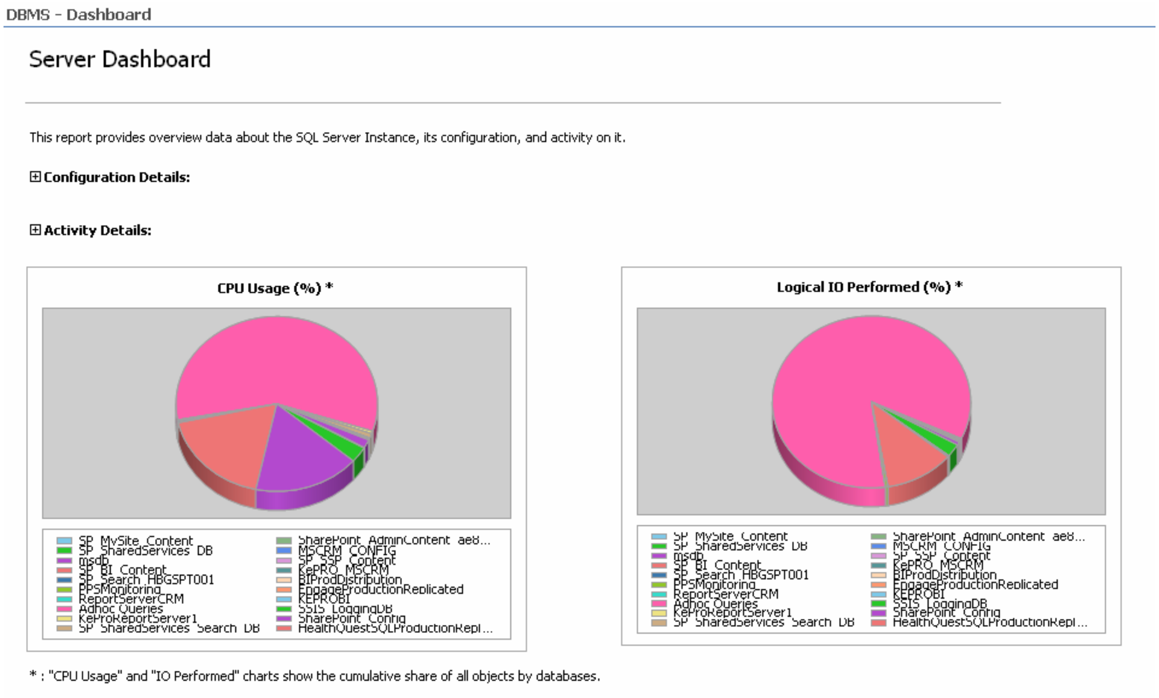


Figure 16: Server Dashboard

4.18.3 ITS Results

ITS improvements as a result of the automated / self-service BI components was significant. The figure below shows the improvement in self-service BI components since the initiative began. The total productivity impact as measured between 2007 and 2010, and which accounts for ITS resources required to produce an equivalent amount of output vs. self-service BI capabilities is estimated at $750,042.86, and increased by 800% throughout the period.

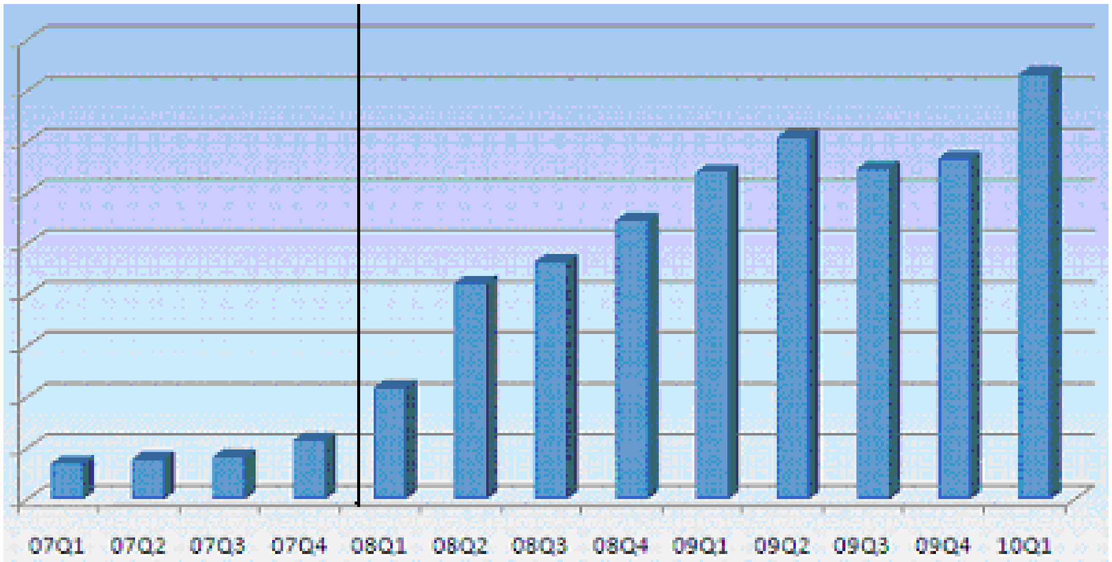


Figure 17: Self-Service BIS Runs

4.19 CASE STUDY – Information Quality Monitoring

4.19.1 Overview

The Information Quality Monitoring initiative was a subset of the Business Intelligence (BI) initiative. This project was intended to improve the data and information quality of identified system components, to help improve overall reporting quality. Additional benefits included improved accuracy, single version of truth, improved end-user satisfaction, reduced cost of fixing quality errors, data transparency, and consistency between source and reference systems.

4.19.2 Information Quality (IQ) Score

An IQ score was calculated using Six Sigma methods for determining defective parts per million (DPMO), and associated sigma level. Layers or levels of information quality were also developed for example:

Level 1 – required field missing / entry error

Level 2 – conditional logic, if closed then require field

Level 3 – business logic, medical decision

After information quality errors were identified a DPMO and sigma were calculated, with equations and case statement listed below:

DPMO = ((Error Count/Total Count) *1E6)

Case ‘IQ Sigma Score’ If DPMO < 3.4 Then 6

ElseIf DPMO <233 Then 5

ElseIf DPMO <6,210 Then 4

ElseIf DPMO <66,807 Then 3

ElseIf DPMO <308,538 Then 2

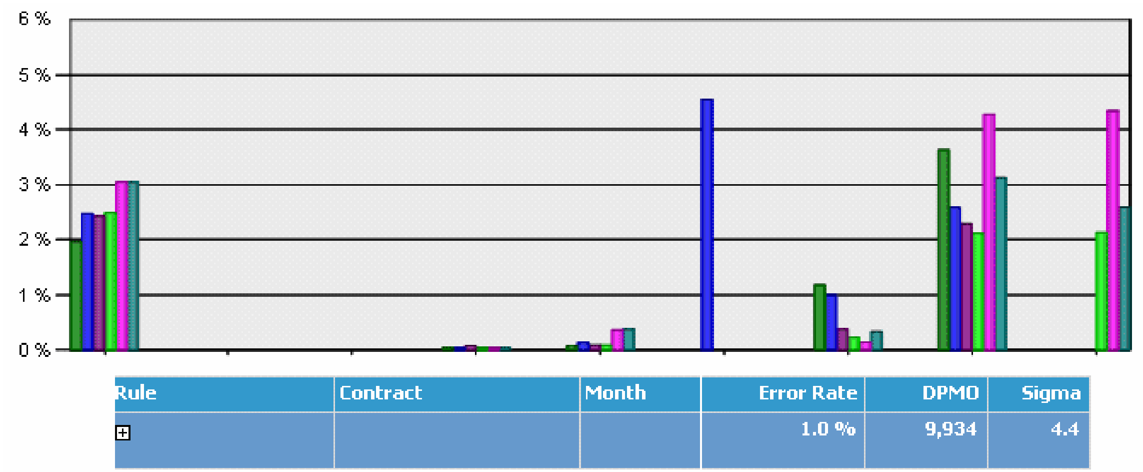


Figure 18: Information Quality (IQ) Score

4.20 Model Components and Data Triangulation Informing Research Study

Table 9: Model Components with Qualitative and Quantitative Data

Model Components and Data Triangulation Informing Research Study

Component	**Description**	**Qualitative and Quantitative Support**

Information quality Refers to information that is accurate, complete, timely, relevant and meaningful in format.	Information quality was seen as a key contributor to learning and associated quality and performance. The BIS improved information quality through a standardized set of data, housed in a centralized data warehouse, allowing for a single-source of truth. Approximately 1000 Key Performance Indicators were also tracked within the centralized data warehouse, allowing information monitoring of critical items across financial, operational, and employee areas. All information was presented through a centralized web site, in a common format with a similar look and feel across data sources and sub-sites. The centralization of information was a key component based on feedback of one sales professional: User requirements were solicited to gauge outputs, and several user-groups were setup to capture feedback on information outputs to allow improvements. Where possible, information was made real-time, with at most 24 hour load periods. Information quality was identified for enlisting additional capabilities, and further extending information sharing and information content across the organization. Information quality is expected to improve decision making and learning, as users are able to identify required information more quickly and easily than before. Information has been codified through knowledge base capabilities, such as document folders, wikis, discussion boards, and self-service reporting capabilities.	I like that all of the company's information is housed in a central location. It saves time from having to email a lot of documents multiple times. I also like that everyone has a general idea of where to find things that they need. This is one of the cleanest dashboards that I have seen. It tells us what we need to know... Nice. Simple. As a frequent user I value the ease of finding and sharing information. However, I have found that many are currently not utilizing the BIS to its fullest potential, and would like to see more information sharing. Going to one site, with roll-up of data in various areas, then drilling down to various sites, with reports, and key measures on a dashboard. 1014 Key Performance Indicators Content currency 135.74 days Versioning 2.88 versions 4.4 Sigma IQ Score
System Quality Rrefers to response time, ease of use, reliability, accessibility, integration, and flexibility.	Prior to the BIS, most data was manually tracked via spreadsheets and stored in multiple database locations, making accessibility and easy use of multiple sources more difficult, in addition no systematic capabilities existed to automatically aggregate and perform analysis. As a result of BIS, system quality improvements were evident along with improved accessibility and ease of use. Prior to the BIS, some system reliability issues and downtime existed, in addition performance was degraded at times of high usage. The BIS resulted in improved reliability, experiencing no unplanned outages during its term in operation, in addition, average system response time, a key measure of system performance, was substantially below the established threshold, and has remained low despite increased usage. It is expected that improved capabilities and performance allow the user to more quickly access information to make decisions which aid learning.	I have received excellent feedback regarding the ease of the data entry and access. There is quicker and easier access to databases, time collection, employees, and benefits; it's like a one stop resource library. Response Time (107 ms vs 4000 ms goal) Unique Visitors Supported: 617 vs. 250 target Bandwidth: 660,158 MB vs. 100,000 MB target Hits: 25,276,079 vs. 3,000,000 target Page Views: 1,474,442 vs. 100,000 target
Service Quality Refers to IS employees which are knowledgeable, support user interests, provide prompt service, and are dependable.	As new information systems typically require large dedicated staff and user support, service quality was also seen to lead to organizational learning through improved IS support of end-users and responsiveness to needs. It is also suggested that through the knowledge and support of end-users, contribution to their learning would occur through improved understanding and knowledge of the overall BIS system.	The staff is available polite and extremely helpful. The BIS support areas demonstrate an unique ability to transform information into a useful format that can be easily understood. I have always received courteous and complete responses to any BIS questions I have posed. The staff is knowledgeable and efficient. Internal Annual Surveys 98% overall satisfied or above with service.

Learning Includes the two referenced mental models; mental-model maintenance, and mental-model building, along with commitment to learning, shared visions, and open mindedness. Organizational Mental Model Maintenance New information is incorporated into existing shared mental models	"Learning in organizations is defined as the process that increases the actionable knowledge of the organization and its members through interpretation, comprehension and assimilation of tacit and explicit information. The processes where knowledge is generated by socialization, externalization and combination are considered organizational learning''. "We conceptualize organizational learning as a continuous improvement process of organizational ideas or behaviors based on the individual employees' interactions with other knowledge agents both inside and outside an organization." The BIS streamlined access and analysis of information for decisions, was seen as a key capability for improvement in learning and resulting organizational quality and competitive performance. Organizational learning has become a critical component of enhancing the competitiveness of a firm. Organizational learning is a key strategy in enhancing competitive advantages, achieving superior performance, and sustainability.	Our department required that all information must be published to the BIS and we changed our habits accordingly. Right now I am on a learning curve, with time, as I get used to using the system, I expect I will value it more Based on the primer you provided me today, I now have full appreciation for the monitoring capabilities provided through the BIS for Service Management. These stats will provide me with invaluable insight into the operation of our Service Desk call center. The BIS has helped us to better understand the organization overall, and the various aspects of the business that we may not have had a clear picture of previously. Internal Survey Perception Support Physician productivity, as measured in cases per hour increased 32.6%, and cost per case decreased by 12.4% year over year. Self-Service BIS runs increased by 800%. Self-Service Report runs: 25,901 vs. 5,000 target.
Quality Organization The quality organization has implemented a set of interdependent behaviors aimed at satisfying its stakeholders.	Organizational quality is seen to contribute to competitive performance by providing support for varying stakeholders. Quality of services as a critical tool for achieving competitive performance, and a mediating variable between learning and performance.	Shareholder Satisfaction: Our ability to deliver on the shareholders' expectation of both growth and profit with corresponding measures which reflect the shareholder's requirements. Customer Satisfaction: Our ability to deliver a quality product to the client is essential to sustaining the organization. We will expand our definition of quality to include clinical, financial, and satisfaction outcomes for our clients. Employee Satisfaction: Employees are the cornerstone to the organization. Our ability to create and sustain a high performing organization of responsibility, accountability, and recognition is paramount to our success. The quality of the support departments have continually improved, even though the resources are limited. Customer Satisfaction: Customer ROI: 25% RI Customer Satisfaction: 15% RI Employee Satisfaction: Involuntary Turnover: 13% Voluntary Turnover 8% RI Financial Satisfaction: Revenue: 2% RI Profit: 4% RI

Competitive Performance Ability to satisfy stakeholder requirements and achieve customer acquisition and positioning within an identified segment.	Competitive performance is the ability to satisfy all stakeholders and hold a favorable position within a competitive segment. Measures include perceived parity with competitors, perceived advantage over competitors, profit or sales less costs, sales or revenue, and overall stakeholder satisfaction. Due to competitive markets and globalization, organizations must continually seek to add value to their services, deliver additional profits, and exceed customer expectations. Information systems can develop a competitive edge through lower costs, or enhanced differentiation.	Being a fairly new employee I am still learning about the BIS however, I am convinced that the more I learn about the BIS it will enhance my performance. The tools and reports the BIS ITS staff develop are very helpful to me in doing my job. Internal perception improvements and support $250,000 in savings over baseline period for physician activity Self-service BI capabilities is estimated at $750,042.86 Year one ROBII is 1419%, with years two through six between 815% and 928%.

4.21 Respondent Characteristics

The table below shows a summary of respondent characteristics. Overall 148 responses were received, with 7 responses removed that were incomplete past general user information, for a total of 141 usable responses. 109 responses were received from the primary study group, with the remaining 32 responses from the control group. 106 respondents were non-managerial users, with the remaining 35 respondents holding a supervisory position through executive position. Users from multiple geographic office locations and functional areas were represented within the study group, as well as users with short and long-term tenure at the firm.

Table 10: Survey Respondent Characteristics

	Study Group	Control Group
Position		
Management	30	5
Professional	79	27
Functional Area		
Sales and Marketing	10	2
Operations	37	8
Medical	19	6
Support Areas	43	16

Tenure		
<2yrs	43	14
>2yrs	66	18
Office Location		
Florida	26	0
Maryland	9	0
Ohio	10	32
Pennsylvania	27	0
Virginia	27	0
Tennessee	10	0

V. ANALYSIS METHODS

5.1 Partial Least Squares

Partial least squares analysis (PLS) is a theory-based approach which combines theory and data, to produce a better result that multivariate techniques. Reliability and validity of the constructs can be assessed between the theory and data. Without causal modeling, only correlations can be calculated, whereas with causal modeling causation can be inferred. PLS is a flexible technique with low requisite assumptions, for example specific distributions and independence of observations are not required. While the measurement and structural parameters are estimated together, the model is developed in two parts, the reliability and validity of the measurement model or quality of the model, and structural model or relationships in the model. The SmartPLS method utilizes a confirmatory rather than exploratory approach, in which the latent constructs are explicitly specified and manifest variables associated are defined a priori, based on theoretical models [18]. Since PLS is partial, normal fit indexes such as chi-squared used in covariance based methods are not used. Instead internal consistency is commonly tested through Cronbach's alpha [96].

For path analysis with latent variables, a two-step approach outlined by Anderson and Gerbing (1988) is followed. The first step utilized confirmatory factor analysis for the measurement model to identify the latent constructs and manifest variables. Path analysis allows testing for discriminant and convergent validity, and excludes error variances of manifest variables from the latent factors and models error separately [97]. The model displays three endogenous variables: organizational learning, competitive performance, and quality organization. The model displays three exogenous variables: individual learning, information quality, system quality, and service quality. In the model organizational learning, competitive performance, and quality organization are also affected by a disturbance term or error term and represents causal effects on the endogenous variables due to various factors such as missing variables or misspecifications.

Following recommended practices, the manifest variables measuring each latent variable are taken from prior research. Manifest variables are directly observed or measured variables. The group of indicators must measure the same latent construct to show high convergent validity and measurement for discriminant validity. This model is a standard model as all latent constructs are measured by more than a single indicator. The model described within is a recursive model, none of the variables are involved in reciprocal causation, and demonstrate only unidirectional causal flow [97].

Power (1-beta) of a statistical test is the complement of beta which describes the type II error of an incorrect null hypothesis. Power relies on significance level or type I error, sample size, and effect size. Post-hoc power analysis utilizes power as a function of alpha, sample size, and effect to determine if a test rejected an incorrect null hypothesis. Cohen's definition of small, medium, and large effect sizes are utilized to determine the degree of null hypothesis violation, with a probability no less than the power [98]. A post hoc power analysis was conducted to determine sample size, and whether a null hypothesis is able to be rejected. Power is computed as a function of alpha, effect size, and sample size. Power analysis is conducted utilizing the G*Power 3 software [98]. The population effect sizes are calculated to determine the sensitivity of the test. Cohen's (1988) small, medium, and large effect sizes were employed, at 0.3, 0.5, and 0.8 respectively [99]. For the study group, a 0.80 power value is achieved with an alpha of 0.05, and effect size of 0.2613688. For the control group, a 0.80 power value is achieved with an alpha of 0.05, and effect size of 0.4556197.

A path analysis is employed using SmartPLS 2.0 software to analyze the results and determine model fit [100]. The rival model with significant loadings is developed. Significance of relationships was determined between individual learning, system quality, information quality, service quality, learning, quality, and competitive performance. The SmartPLS HTML output report as shown below generates as a result of the PLS generation.

The first section of the SmartPLS output displays the quality of the model. The average variance extracted is indicated by the column AVE, and is the average communality for the latent factors in the model. AVE is utilized for convergent validity, and should be greater than or equal to 0.5. AVE exceeded 0.5 in this study [96, 100].

Composite reliability is also utilized as Cronbach's alpha commonly underestimates or overestimates reliability. Composite reliability follow's similarly to Cronbach's alpha, with 0.80 to be considered good, 0.70 to be considered acceptable, and 0.60 to be considered for exploratory requirements. All composite reliabilities exceeded 0.80 [96, 97, 100].

R-Square displays the effect size measure, and is not shown for exogenous constructs. An R-Square of 0.67 is considered substantial, 0.33 considered moderate, and 0.19 considered weak. All R-square values exceeded moderate, and some substantial .

Reliability among factors within the same subset was tested using Cronbach's alpha as the reliability coefficient for internal consistency. Cronbach's alpha should be equal to at least 0.80 to be considered good, 0.70 to be considered acceptable, and 0.60 to be considered for exploratory requirements. With an Alpha equal to 1 representing perfect correlation. A typical rule of thumb for acceptance is a loading of 0.7 or above. All latent constructs exceeded the 0.7 loading. For short scales, Cronbach's alpha may be biased, this study utilized 7 point scales for all questions measured [96, 97, 100].

Communality explains the reliability of a row factor, and is the squared multiple correlation for the variable as a dependent and factors as independent. The communality value should be evaluated within the model, and the value itself should not be considered, but the interpretation of the value. In cases where communality is grater than 1, a spurious solution may exist in which a sample size is not large enough or the number of factors is too large or small [96, 100].

Redundancy is the percent of variance in the independent factors for the dependent. The redundancy test can be utilized to compare a one-factor and multi-factor model, and if models perform equally, can choose the one-factor model based on parsimony [96, 100].

Table 11: Measurement Model Quality

	AVE	Composite Reliability	R Square	Cronbachs Alpha	Communality	Redundancy
F1_CompPerf	0.685915	0.896920	0.710577	0.846198	0.685915	0.385827
F2_OrgQual	0.610924	0.865955	0.523874	0.792398	0.610924	0.324446
F3_OrgLearn	0.546113	0.905166	0.813124	0.879699	0.546113	0.079843
F4_ServQual	0.723636	0.928989		0.904354	0.723636	
F5_SysQual	0.597170	0.879920		0.827853	0.597170	
F6_InfoQual	0.629282	0.910248		0.881090	0.629282	
F7_Individual_Learn	0.825577	0.904451		0.788952	0.825577	

The latent variable correlations table displays factor correlation coefficients [96, 100].

Table 12: Latent Variable Correlations

	F1_CompPerf	F2_OrgQual	F3_OrgLearn	F4_ServQual	F5_SysQual	F6_InfoQual	F7_Individual_Learn
F1_CompPerf	1.000000						
F2_OrgQual	0.764914	1.000000					
F3_OrgLearn	0.798068	0.723791	1.000000				
F4_ServQual	0.721360	0.578881	0.728095	1.000000			
F5_SysQual	0.769788	0.727044	0.867313	0.781212	1.000000		
F6_InfoQual	0.704495	0.683667	0.837439	0.725381	0.874064	1.000000	
F7_Individual_Learn	0.718158	0.681909	0.779961	0.570340	0.737516	0.727185	1.000000

The latent variable cross loadings displays the loadings on the expected factors and the loadings on the remaining factors. The model should have high loadings on the expected factors, and low loadings on the remaining factors. The cross-loadings may be higher in more complex factor structures, and are more meaningful in simple factor structures [96, 100].

Table 13: Latent Variable Cross-Loadings

	F1_CompPerf	F2_OrgQual	F3_OrgLearn	F4_ServQual	F5_SysQual	F6_InfoQual	F7_Ind_Learn
V10_Learn_OrgLearnComm	0.610410	0.584146	0.768253	0.569676	0.677878	0.719065	0.636483
V11_Learn_OrgSharedVisions	0.511258	0.512837	0.689541	0.397687	0.535412	0.526253	0.551803
V12_Learn_OrgCommit	0.533515	0.530922	0.754566	0.533140	0.619469	0.569455	0.572750
V13_Learn_OrgLearn	0.563450	0.549023	0.720046	0.521464	0.580827	0.610878	0.552312
V14_Learn_OrgOpenMind	0.407286	0.315893	0.613378	0.398522	0.484043	0.505497	0.323633

V15_Learn_MMMOrg	0.733343	0.634276	0.853363	0.657444	0.755588	0.713455	0.746517
V16_Learn_MMBOrg	0.704909	0.601795	0.699639	0.603939	0.680605	0.604770	0.603189
V1_CP_Competitiveparity	0.867567	0.615830	0.730177	0.650182	0.697232	0.620040	0.599148
V21_Learn_MMBIndividual	0.659480	0.592919	0.731764	0.545729	0.683910	0.642293	0.915016
V22_Learn_MMMIndividual	0.645378	0.648385	0.684310	0.489026	0.655659	0.680734	0.902163
V23_SrvQ_Assurance	0.645566	0.547906	0.638591	0.864248	0.649697	0.603080	0.493014
V24_SrvQ_Empathy	0.621178	0.513835	0.657242	0.856395	0.683842	0.618615	0.433973
V25_SrvQ_Reliability	0.596316	0.425666	0.633817	0.853945	0.658852	0.605790	0.528775
V26_SrvQ_Softwareuptodate	0.624991	0.524716	0.582107	0.805512	0.682431	0.640376	0.527037
V27_SrvQ_Responsiveness	0.577714	0.447792	0.577095	0.871650	0.647704	0.620033	0.445011
V28_SQ_Flexibility	0.704171	0.619422	0.690145	0.729870	0.850886	0.683253	0.564588
V29_SQ_Integration	0.655310	0.619595	0.840168	0.681155	0.857285	0.782696	0.656733
V2_CP_Competitiveadvantage	0.879469	0.738561	0.680981	0.560237	0.658031	0.583347	0.662625
V30_SQ_easeofuse	0.542269	0.638232	0.595227	0.495212	0.716222	0.737998	0.609485
V31_SQ_AnalysisCapability	0.573160	0.515110	0.672870	0.578880	0.623495	0.712435	0.564657
V32_SQ_Reliability	0.568402	0.530674	0.625385	0.582542	0.777372	0.731870	0.576847
V33_SQ_Verticalintegration	0.481996	0.382209	0.551151	0.498521	0.640018	0.403888	0.421794
V34_IQ_Currency	0.491658	0.490276	0.562972	0.433917	0.606372	0.735250	0.487185
V35_IQ_Accessibility	0.653969	0.617931	0.708252	0.674309	0.750762	0.817574	0.616918
V36_IQ_Completeness	0.588733	0.629543	0.726009	0.578496	0.794825	0.858331	0.621977
V37_IQ_Accuracy	0.550184	0.484316	0.649279	0.572600	0.671696	0.821031	0.563305
V38_IQ_Format	0.476595	0.496637	0.645251	0.589546	0.690917	0.805088	0.590124
V3_CP_Profit	0.810211	0.634967	0.644952	0.628755	0.644942	0.637784	0.607378
V4_CP_Sales	0.749054	0.529134	0.580582	0.554587	0.540726	0.486059	0.497806
V5_QO_CustomerSatisfaction	0.663207	0.866160	0.616464	0.407358	0.613180	0.542677	0.605721
V6_QO_EmployeeSatisfaction	0.500202	0.766043	0.580522	0.450711	0.588575	0.589990	0.604542
V7_QO_ShareholderSatisfaction	0.610885	0.703559	0.454994	0.472845	0.499247	0.449257	0.411480
V8_QO_Quality	0.625207	0.802276	0.615355	0.498770	0.583358	0.569077	0.518610
V9_Learn_OrgLearnShare	0.578146	0.482564	0.788311	0.558868	0.734991	0.661370	0.534764

The outer model coefficients displays the manifest variables and the path to the latent constructs. This output simplifies the cross loadings output [96, 100].

Table 14: Latent Variable Cross-Loadings Outer Model

	F1_CompPerf	F2_OrgQual	F3_OrgLearn	F4_ServQual	F5_SysQual	F6_InfoQual	F7_Ind_Learn
V10_Learn_OrgLearnComm			0.768253				
V11_Learn_OrgSharedVisions			0.689541				
V12_Learn_OrgCommit			0.754566				
V13_Learn_OrgLearn			0.720046				
V14_Learn_OrgOpenMind			0.613378				
V15_Learn_MMMOrg			0.853363				
V16_Learn_MMBOrg			0.699639				
V1_CP_Competitiveparity	0.867567						
V21_Learn_MMBIndividual							0.915016
V22_Learn_MMMIndividual							0.902163
V23_SrvQ_Assurance				0.864248			
V24_SrvQ_Empathy				0.856395			
V25_SrvQ_Reliability				0.853945			
V26_SrvQ_Softwareuptodate				0.805512			
V27_SrvQ_Responsiveness				0.871650			
V28_SQ_Flexibility					0.850886		
V29_SQ_Integration					0.857285		
V2_CP_Competitiveadvantage	0.879469						
V30_SQ_easeofuse					0.716222		
V31_SQ_AnalysisCapability						0.712435	
V32_SQ_Reliability					0.777372		
V33_SQ_Verticalintegration					0.640018		
V34_IQ_Currency						0.735250	
V35_IQ_Accessibility						0.817574	
V36_IQ_Completeness						0.858331	
V37_IQ_Accuracy						0.821031	
V38_IQ_Format						0.805088	
V3_CP_Profit	0.810211						
V4_CP_Sales	0.749054						
V5_QO_CustomerSatisfaction		0.866160					
V6_QO_EmployeeSatisfaction		0.766043					
V7_QO_ShareholderSatisfaction		0.703559					
V8_QO_Quality		0.802276					
V9_Learn_OrgLearnShare			0.788311				

The total effects or structural model path coefficients is displayed below between the latent constructs [96, 100].

Table 15: Model Total Effects

	F1_CompPerf	F2_OrgQual	F3_OrgLearn	F4_ServQual	F5_SysQual	F6_InfoQual	F7_Ind_Learn
F1_CompPerf							
F2_OrgQual	0.393340						
F3_OrgLearn	0.798068	0.723791					
F4_ServQual	0.087310	0.079184	0.109402				
F5_SysQual	0.310578	0.281672	0.389162				
F6_InfoQual	0.177562	0.161036	0.222490				
F7_Ind_Learn	0.214489	0.194526	0.268760				

The standardized latent variable scores are displayed below. These scores can be utilized for outlier identification. If an absolute value is greater than 1.96 at the 0.05 level or 2.58 at the 0.01 level [96, 100].

Table 16: Standardized Latent Variable Scores

	F1_CompPerf	F2_OrgQual	F3_OrgLearn	F4_ServQual	F5_SysQual	F6_InfoQual	F7_Ind_Learn
	-0.431736	0.552932	0.475244	-0.182099	-0.244673	0.943097	-0.811583
	2.083957	2.224317	1.847436	1.540585	1.859277	1.548408	1.512949
	0.858442	1.137376	0.636886	1.342032	0.682249	0.958284	0.586437
	-0.922135	-0.905382	-0.790789	-1.661791	-0.941511	-0.423435	-0.356579
	-0.661648	-0.277779	0.368103	0.259801	0.169065	0.582584	0.131433
	-1.412534	-1.972244	-1.978801	-1.661791	-2.380036	-2.950688	-2.193099
	1.168304	1.127336	1.371169	1.107781	0.971766	1.566728	1.041441
	0.634957	-0.025845	0.251945	0.053623	0.106422	-0.024738	0.131433
	-2.212313	-0.644779	-1.235917	-0.959038	-0.852452	-1.570690	-3.119611
	0.101610	-1.165985	-0.994915	0.252177	-0.794057	-0.212846	-0.340075
	1.081927	1.364859	0.934577	0.074195	0.771933	1.344412	1.512949
	0.073951	-0.880931	-1.150570	-1.032460	-1.507613	-1.412114	-0.795079

	-0.158877	-0.364021	-0.166717	0.017925	-0.145264	0.345502	0.114929
	0.880157	0.239130	0.692226	1.540585	1.859277	1.347966	1.057945
	1.327126	0.259209	0.815449	1.540585	0.741622	0.958985	1.041441
	0.634957	1.668621	1.288579	1.540585	1.286721	0.758543	1.057945
	1.305411	1.678660	1.664225	1.319635	1.604320	1.551541	1.041441
	-0.404077	-0.591581	-0.447601	-1.440841	-0.866964	-1.012436	-0.340075
	1.305411	0.833614	0.963346	1.085384	0.852934	0.949690	1.057945
	-2.926197	-0.895343	-3.763748	-1.661791	-2.229312	-3.018149	-3.119611
	-0.922135	-1.165985	-1.713195	-1.661791	-1.924621	-1.792584	-1.266587
	1.081927	1.094216	0.746732	0.473127	0.597978	0.564264	0.586437
	-0.431736	-0.634740	0.144118	1.342032	-0.549364	0.169542	-1.250083
	-0.401160	-0.880931	-0.152881	0.059422	-0.208532	0.178837	-0.323571
	-0.465822	-0.605992	0.629534	0.710674	0.535335	0.377455	-1.233579
	-0.404077	-0.591581	-1.277430	-1.440841	-1.433066	-1.203583	-0.811583
	-0.922135	-1.165985	-1.055815	-1.661791	-1.613476	-1.792584	-1.266587
	0.064607	-0.634740	-0.801590	-0.826758	-0.549364	-0.387927	-0.811583
	-1.467853	-1.112786	-2.736045	-1.661791	-2.446488	-1.792584	-1.266587
	-1.369105	-0.591581	-1.798155	-1.669415	-1.034465	-1.598305	-1.266587
	-0.676936	-0.644779	-0.350896	-1.264684	-0.941511	-0.041047	-0.795079
	-0.922135	-0.644779	-0.176894	-0.158232	-0.403491	-0.645330	-0.795079
	-0.431736	0.239130	-0.469442	-0.390456	-0.034577	-0.809563	0.114929
	0.089239	0.552932	0.549662	-0.365881	0.190694	0.564264	0.586437
	0.607298	1.098589	0.894357	0.487899	1.430365	1.134244	0.586437
	-0.401160	-1.165985	0.435169	0.710674	-0.238219	0.373117	-0.340075
	2.083957	1.369155	0.847740	1.540585	1.859277	1.742688	-0.356579
	-0.922135	-0.581541	-0.240823	-0.365881	-0.774635	-0.235327	-0.340075
	-0.404077	0.809162	-0.886871	0.473127	-0.941511	-0.221263	0.586437
	-2.522175	-1.456706	-0.955279	-0.422027	-0.630365	-0.432730	-0.340075
	-0.186537	0.524108	-1.182868	1.540585	0.445650	-0.215101	-0.356579
	0.836727	1.094216	0.969739	0.707378	1.023081	0.934503	1.041441
	-0.922135	-1.165985	0.123947	-0.751389	-0.085892	0.373117	-0.356579
	-0.900421	-1.736093	-2.227634	-1.661791	-1.774523	-1.981299	-0.795079
	0.634957	1.094216	0.323659	0.473127	0.597978	0.564264	0.586437
	0.585583	1.094216	0.381962	0.473127	0.424022	0.564264	0.586437
	-0.177675	-0.277779	-0.153586	-0.437276	-0.294407	0.354797	0.586437
	1.550611	-0.017176	1.166747	1.540585	1.859277	1.321052	1.512949

	-0.602930	-1.475490	0.092848	-0.598184	0.660621	0.547253	1.057945
	-0.229966	-0.852183	-0.359445	0.296970	-1.583790	-1.396132	-0.340075
	0.362098	0.210307	0.179553	0.473127	-0.319220	0.564264	-0.828087
	0.352755	0.277917	-0.173744	-0.594332	-0.171766	-0.028292	-0.340075
	0.291009	0.259209	0.293761	0.274573	-0.459680	-0.411287	0.114929
	0.030521	0.562971	-0.399747	-0.607279	0.139379	-0.219439	-0.811583
	-1.006867	0.109682	-0.127184	0.000000	0.140925	0.247910	0.254635
	0.129270	0.809162	0.206809	0.473127	0.394336	0.174581	0.586437
	0.548580	0.562971	-0.106691	0.038497	0.343021	0.564264	0.586437
	-0.416448	-0.320938	0.791163	0.473127	0.909123	0.361390	0.586437
	0.089239	-0.644779	-0.128322	0.944925	0.112877	-0.032631	0.114929
	1.054267	1.094216	1.459098	1.540585	1.685321	1.566728	1.512949
	0.662617	0.528481	0.386610	0.673505	1.089533	1.153265	1.041441
	-0.453451	-0.099122	-0.080895	0.707378	-0.223081	0.567397	0.569933
	0.144558	0.552932	0.216645	0.238876	0.190694	0.373117	0.586437
	-1.167335	-1.190436	-1.102018	-1.461412	-1.229424	-1.194989	-0.811583
	-2.910909	-3.169956	-2.890660	-1.661791	-2.012702	-2.003958	-2.664607
	1.327126	0.263505	0.685832	1.141653	0.690307	-0.001378	1.057945
	1.081927	0.780415	0.520729	0.694077	0.597978	0.564264	0.586437
	0.116898	-0.581541	-0.094577	0.473127	-0.178846	0.142628	-0.795079
	-0.922135	-0.538382	-0.931699	-1.661791	-1.115466	-0.975105	-1.266587
	0.634957	0.552932	0.632239	0.473127	0.597978	0.158516	0.586437
	0.759693	-0.310899	-0.370925	1.540585	0.915577	0.977727	0.131433
	-1.651307	-0.538382	-0.838968	-1.869794	-0.804321	-0.226910	-1.283091
	0.079896	0.267878	0.261076	0.686452	0.909123	0.154261	0.586437
	1.081927	1.094216	0.632239	0.473127	0.915577	0.783025	1.041441
	1.081927	1.094216	0.632239	0.473127	0.597978	0.564264	0.586437
	-0.922135	0.296625	0.546315	-1.219891	-0.289533	-0.618416	0.586437
	-0.431736	-0.359725	0.161325	-0.161881	-0.433803	0.006010	0.586437
	1.565899	1.963714	1.847436	1.540585	1.481679	0.977305	1.041441
	-0.431736	0.524108	0.326642	-1.191818	-0.142080	0.369984	0.131433
	-0.676936	-0.852183	-0.888827	-1.841244	-0.804321	-0.217007	-0.811583
	2.083957	1.683032	1.847436	1.540585	1.481679	1.547285	1.512949
	-0.404077	-0.644779	0.661159	0.473127	0.424022	0.388304	1.041441
	-0.676936	-1.165985	-1.530152	-0.193929	-1.118737	-1.799178	-1.266587
	-0.922135	-0.591581	-0.936960	-0.813811	-0.804321	-0.414841	-0.340075

	-0.155961	-0.538382	0.498812	-0.195400	-0.178846	-1.001925	1.041441
	-0.401160	-0.306526	0.016933	0.473127	0.343021	-0.036886	-0.811583
	-0.698651	-1.165985	-1.324670	-1.240109	-0.918904	-1.443798	-1.266587
	-0.404077	-0.905382	0.395435	-0.347134	-0.714637	-0.416326	1.057945
	-0.922135	-1.165985	-0.579988	0.246854	0.190694	0.349663	0.131433
	1.587614	0.833614	1.397447	0.920703	1.655635	0.949690	-0.323571
	0.129270	0.823574	0.091275	-1.427540	0.364649	0.158516	0.586437
	0.858442	0.562971	0.198752	0.238876	-0.352176	0.345502	0.114929
	1.081927	-0.017176	0.470610	0.473127	0.741622	-0.251392	0.586437
	0.809068	0.292329	0.477949	0.473127	0.190694	0.564264	0.131433
	0.150985	1.668621	-0.210836	0.004624	-0.426723	0.361390	0.114929
	1.081927	1.094216	0.492767	0.473127	0.801620	0.564264	0.586437
	0.101610	0.833614	0.360045	-0.350632	0.597978	0.345502	0.586437
	1.587614	0.538520	1.493434	1.540585	0.819439	0.949690	0.586437
	-0.986798	-1.233595	-0.582958	-0.792886	-1.376877	-0.825628	-0.340075
	0.113982	0.552932	0.354706	0.076019	0.597978	0.212344	0.586437
	0.836727	-0.277779	-0.265096	-1.000889	-1.069002	-2.044853	-0.340075
	0.052236	-0.267740	0.844065	-0.822784	1.119219	0.794752	1.512949
	-1.157991	-2.831626	-0.380975	0.473127	-0.408990	-0.614160	-3.136115
	0.895445	-0.017176	0.049109	-0.326209	-0.489991	-0.835354	0.114929
	-0.416448	0.239130	0.155972	0.076019	-1.071231	-0.848810	-0.340075
	-0.431736	0.267878	-0.102057	-0.365881	0.139379	0.564264	0.114929
	1.413503	2.224317	1.847436	1.540585	1.859277	1.566728	1.512949
	0.368043	0.833614	0.743749	0.473127	0.801620	-1.292547	0.131433
	-0.155961	0.552932	0.323659	-1.248087	0.169065	0.373117	0.114929

The bootstrapping results for the path coefficients are displayed below. The T-statistic is utilized to calculate significance within the model [96, 100].

Table 17: Bootstrapping Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	Standard Error (STERR)	T Statistics (|O/STERR|)
F2_OrgQual -> F1_CompPerf	0.393340	0.401246	0.066762	0.066762	5.891703
F3_OrgLearn ->	0.513372	0.507245	0.071811	0.071811	7.148946

F1_CompPerf					
F3_OrgLearn -> F2_OrgQual	0.723791	0.725832	0.049910	0.049910	14.502041
F4_ServQual -> F3_OrgLearn	0.109402	0.115585	0.066670	0.066670	1.640949
F5_SysQual -> F3_OrgLearn	0.389162	0.385267	0.117984	0.117984	3.298426
F6_InfoQual -> F3_OrgLearn	0.222490	0.230269	0.099379	0.099379	2.238800
F7_Individual_Learn -> F3_OrgLearn	0.268760	0.266647	0.077267	0.077267	3.478314

5.2 Assumptions

PLS carries a set of assumptions, though generally PLS does well to accommodate missing values, model misspecification, and violation of common latent variable assumptions [96, 97].

Table 18: Model Assumptions

Assumption	Study Description
Multicollinearity	PLS utilizes orthogonal factors, in which multicollinearity issues are limited, with PLS preferable to structural equation modeling.
Standardization	All variables are centered and standardized in the measurement tool.
Interval data	Interval or ratio measurement for manifest variables. This is assumed based on the likert scale measurement used in the survey.
Sample size	PLS has been successfully used for very small samples of less than 20, however larger samples may yield more reliable results. Using power equal to 0.80, factor loadings of 0.70, and correlations greater than 0.60, are utilized to determine sufficient sample sizes.
Distribution	PLS utilizes a distribution-free approach, in contrast SEM requires multivariate normality
Significance	Bootstrapping is utilized to test significance as traditional significance testing is not available.
Parsimony	PLS is principal component based, whereas SEM is covariance based. PLS has also been found to be more parsiminous than principal component regression. The inclusion/exclusion of variables will affect the results. Selecting the model structure in advance produces the best analysis. Also if variables are excluded to produce ‘cleaner’ solutions, results and conclusions may be in error.
Errors	PLS models without error and endogenous latent factors without disturbance, whereas SEM models the errors.
Variables	T-statistic for each variable is 1.96 or greater.
Reliability	Composite reliabilities for latent factors are 0.70 or greater.
Variance	Variance for latent factors are 0.50 or greater.

VI. RESULTS

Results show that 81% of the variability in Organizational Learning, 52% of the variability in Quality Organization, and 71% of the variability in Competitive Performance is explained from the model. The path analysis model describes the relationships between the latent variables and manifest variables which measure the latent variables. The original research model includes seven latent variables of Individual learning, information quality, system quality, service quality, organizational learning, quality organization, and competitive performance. All latent constructs exceeded a 0.70 composite reliability benchmark, which is a measure of the internal consistency of the manifest variables on the latent factor. The hypotheses were found to be significant at varying levels. Figure 19 displays the study group model significance, individual learning are found to not be significant. Information quality and system quality are found to form a significant relationship with organizational learning. Service quality exhibited a weak significance with organizational learning. Learning on quality and competitive performance, and quality on competitive performance formed a significant relationship.

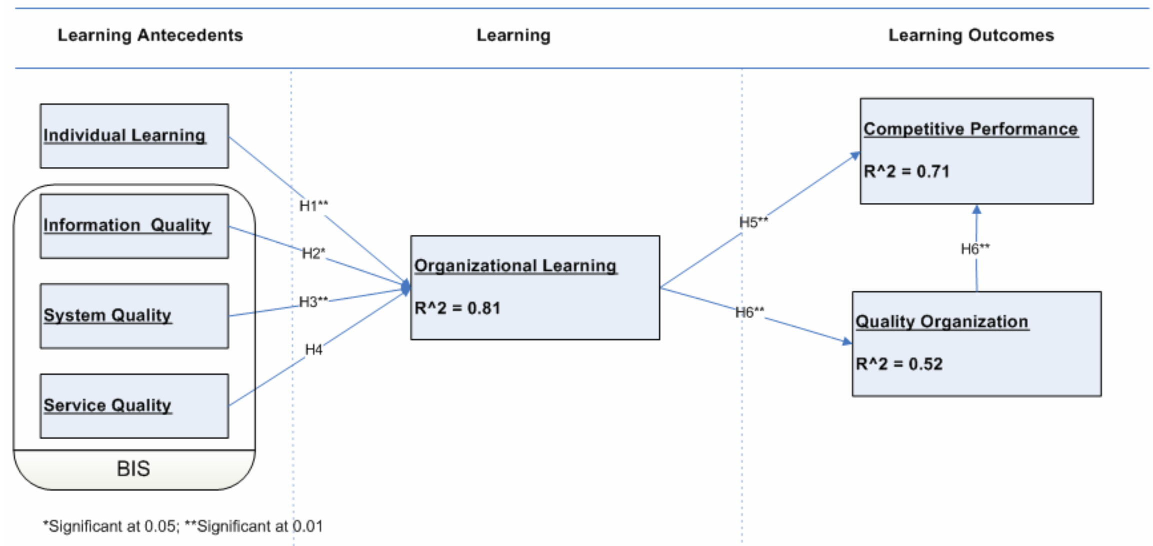


Figure 19: Study Group Model Significance

Prior IS literature has found links with individual characteristics, information, service and system characteristics on use and acceptance. Prior literature with regard to ESS, found no significant link between individual characteristics and model-building and model-maintenance. Prior literature did find a link between system characteristics and mental-model building.

The control group model significance is shown in Figure 20, information quality and service quality displayed no significance, though system quality remained significant. Individual learning were found to show weak significance. Learning showed significance on quality, but weak support for competitive performance.

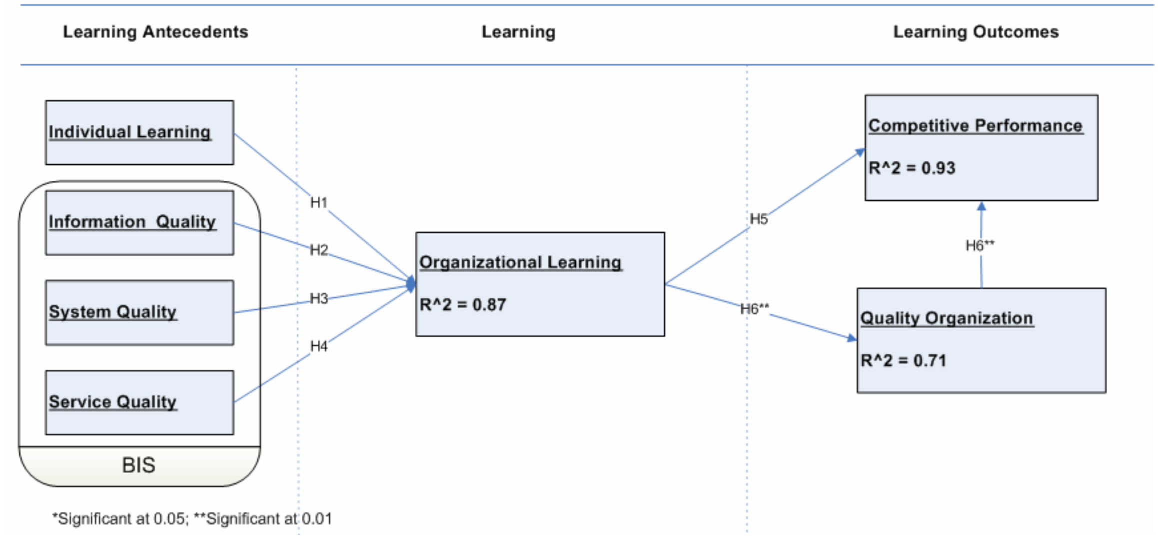


Figure 20: Control Group Model Significance

The final BIS model specification for the study group is shown in Figure 21. This includes the supported paths and latent constructs, these include information quality, system quality, service quality, learning, quality organization and competitive performance. The table below displays the significance level of support for the study group and control group for each hypothesis, along with the power analysis results, and case study results to form triangulation. Triangulation combines multiple methodologies, such as qualitative and quantitative methods, as complementary components for improving research study accuracy [101]. Power analysis is also shown for the study group and control group. Direct effects between learning antecedents and learning outcomes were also explored. The control group results showed that no significant direct effects existed between learning antecedent and learning outcomes. The mediator variable organizational learning, explains a greater variance through the incorporation of internal psychological significance. To test for mediation, the relationships between the dependent and independent variables, and the relationships between the mediator and dependent variables are explored. All relationships are significant, except for service quality which is removed from the final model specification.

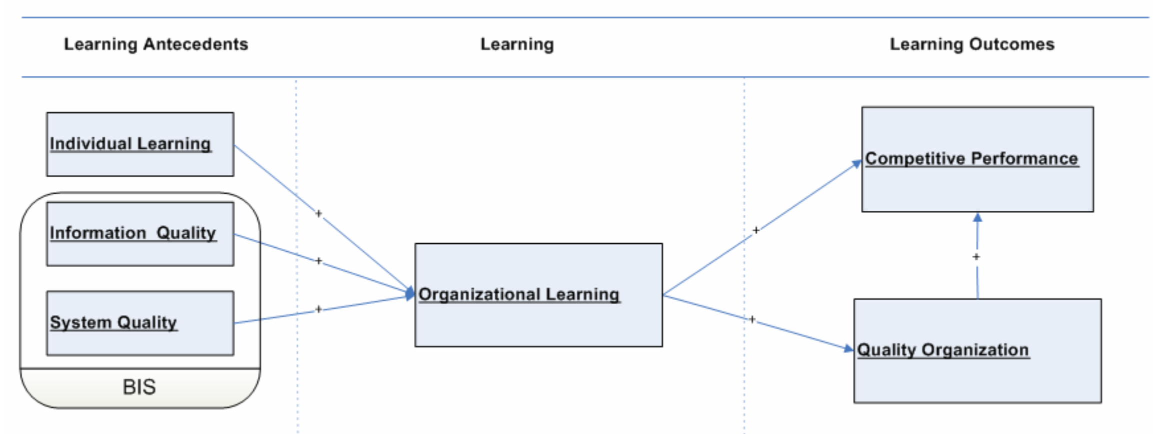


Figure 21: Final BIS Model Specification

Table 19: Model Significance

	Significance Level	
Hypothesis	**Study Group**	**Control Group**
H1: Individual Learning -> Learning	0.01	Not Supported
H2: Information Quality -> Learning	0.05	Not Supported
H3: System Quality -> Learning	0.01	Not Supported
H4: Service Quality -> Learning	Not Supported	Not Supported
H4: Learning -> Competitive Performance	0.01	Not Supported
H5: Learning -> Quality	0.01	0.01
H6: Quality -> Competitive Performance	0.01	0.01
Power Analysis	**Study Group**	**Control Group**
Power	0.80	0.80
Alpha	0.05	0.05
Effect Size	0.26	0.46

VII. DISCUSSION

7.1 Overview

In a typical system implementation, after the first version is released to users, the sustaining phase is reached. The system may add additional applications, users, or features, such as more timely updates. In past studies, professional users were more interested in managing ongoing changes, and evolutionary development approaches then compared with executives [35]. This study reviews the use of BIS, and the ability for improving management of ongoing changes, and contribution to learning, quality, and performance.

Individual learning was anticipated to form a relationship with organizational learning, and in the study group individual learning was found to be significant. This is an important distinction within BIS vs. prior decision support systems, as the systems are accessed by and provide capabilities for virtually all stakeholders instead of executives or a select group only. While executives may have the greatest influence in decision making, it is also the day-to-day operational level employees and various stakeholders who also make decisions that can influence the organization and other stakeholders. It is this access to information that allows learning through mental-model building and mental-model maintenance to occur. The control group found no significance with regard to individual learning and organizational learning. Through lack of BIS capabilities and information, it is considered that individual learning plays a greater role in learning within the control group vs. the study group where individual learning plays a significant role in the face of readily available information and BIS capabilities.

System quality is another factor anticipated to form a relationship with learning, and was found to be significant for the study group. The feature set within the system is an important contributor for the stakeholder to produce the required information. In other words, allowing the user to answer the question, or answer new questions previously not thought of. Key within the set of variables is the analysis capability. These analysis capabilities may include advanced data mining features or simple intuitive reporting capabilities. BIS incorporates a larger expanse of functions and applications, whereas prior ESS systems were limited in their scope and feature set due to cost or knowledge considerations. The control group also found significance in the relationship with learning. The control group had exposure to the system training and review, and in discussions heard from active users to the capabilities and reliability of the system, which contributed to the significance.

Information quality was found to form a significant relationship with learning in the study group. This is not found to be different than in ESS systems, as information quality is a pervasive trait. It is important for users to be confident in the information and the resulting decisions and mental models that are generated in response to the information. Trust is a major factor in the routine use of a system, and information quality plays an important role. The control group did not form a significance relationship with learning as a result of the limited information accessibility, and associated limited frequency of decision making.

Learning at individual, team, and organizational levels was found to form significant relationships with competitive performance and being a quality organization. While mental-model building was previously found to impact competitive performance, mental-model maintenance through use of BIS is also found to impact competitive performance, with mental models included as variables within organizational learning. While executives may be interested in long-term competitive performance and quality achieved through mental-model building, management staff and professional employees are interested in short-term performance goals and quality improvements achieved through mental-model maintenance. This may include new processes or procedures or new tools to enhance ongoing performance. This could be as simple as adapting the schedule to optimize production, better response to an influx of orders, or quality identification areas. Combined these are seen to positively improve the short and long-term sustainability quality and performance of the organization, with BIS providing the information and performance management capabilities to drive the organization forward.

Quality organization was found to have a significant relationship with competitive performance. Within healthcare, quality is an important aspect from improving delivery of services, to patient care, and quality of life. The combination of employee, customer, and shareholder satisfaction along with quality healthcare services, contributes to overall competitive performance of an organization. BIS contributes to learning and resulting quality of the healthcare organization through quality monitoring and predictive capabilities delivered through dashboards, scorecards, and reporting functions.

To achieve competitive performance, organizations must support quality programs and organizational learning vis-à-vis BIS. Learning and quality were found to form a significant relationship with competitive performance. In the control group, weak significance was found with regard to learning and competitive performance. This suggests that BIS capabilities increase the significance in relationship between learning and competitive performance. Individual learning at a position/level were not found to significantly contribute to learning and subsequent performance. This is important as earlier notions of the resource-based-view of the firm held that only managerial talent led to competitive advantages. It is important to note that through BIS, individual users can contribute to a firm’s competitive advantage. This necessitates the need to retain key staff both at professional contributor and managerial levels. The knowledge based theory of the firm also identifies that the knowledge developed and captured through a BIS and learning, can create a significant resource leading to sustained competitive advantages.

7.2 BIS Implications

Organizational knowledge creation and learning is a required component for today's healthcare organizations to improve quality and performance. The increasing amounts of information require BIS capabilities to assist with learning via mental models. Increasing stakeholder demands for information also necessitate BIS implementation across all user entities and areas of the organization. This study found a significant relationship between information quality and organizational learning. This finding demonstrates that information quality is a requirement to learning and subsequent competitive performance of an organization, and suggests that information quality is a key priority in the development of a firm's competitive position.

In user feedback, information and system quality and the BIS to deliver quality information had the greatest impact for improvement and continued contributions to organizational learning, healthcare quality, and competitive performance. This is important as new users enter the organization, and as existing users change roles and responsibilities over time. Key recommendations include making BIS information immediately accessible to all stakeholders, and continuing to expand information quality and knowledge through increasing analysis, trending, and predictive information capabilities.

Some of the key findings and recommendations with regard to systems quality include site to site and enterprise application and information integration, enterprise systems consolidation, exclusion of non-supported vendor legacy applications from any work scope due to integration issues and limited support, adding cost assumptions for contract specific restrictions and added integration costs, limiting customizations to avoid upgrade issues and legacy lock-in, and maintaining current or n-1 major version for all software components across all instances. Maintaining current versioning is key in order to take advantage of new features and performance improvements, in order to resolves common bug fixes, ensure software support by the vendor when issues arise, and ability to find resources within established parameters greatly improves. Often after implementation, little attention is paid to continuing upgrades and enhancements, often re-creating the original issues of legacy systems and capabilities, as well as continuing bug issues and lack of vendor support, leading to costly internal resourcing or external consulting arrangements.

From a systems hardware/software platform perspective it is important to align software and hardware purchases with BIS vertical platform architecture to avoid integration issues, as in historical case studies up to 40% implementation costs are typically spent on integration, due to the complexities of integrating multiple vendor components and hardware support. Along these same lines utilizing a single vendor vs. best of breed for small-medium business scenario significantly reduces costs and eases time to implementation. It is also critical to assign short-term dedicated consultant resources to improve timeline and knowledge transfer for existing staff, particularly in cases where the software application has limited internal expertise. Using a common vendor with wide knowledge bases for faster resolution of issues assists greatly, and a large community offers opportunities for identifying and resolving common items. Staging and test environments can be omitted to reduce costs and speed deployment. Often the cost of maintaining staging and test environments are not adequately considered and often become out of date and no longer match the production environment. It is important to consider whether a structured process and resource allocation is in place to support necessary environments and plan accordingly. In some cases only critical components can be tested in development to reduce costs and speed deployment. A sample vertical architecture is shown below, based on a Microsoft BIS stack with Windows operating system, SQL Server as database management system,

.NET as the development framework, IIS as the web server, Office and CRM as the end-user tools, and SharePoint as the content and knowledge management system.

Service quality was found to not form a significant relationship with organizational learning. It is suggested that service quality may vary widely based on the particular support area or individual representative, and the limited interaction with that individual in a learning capacity. Instead the information and system quality capabilities, coupled with one's own ability to learn and form individual learning, leads to organizational learning, where daily variances in service quality are not large enough to display a significant affect on the overall population.

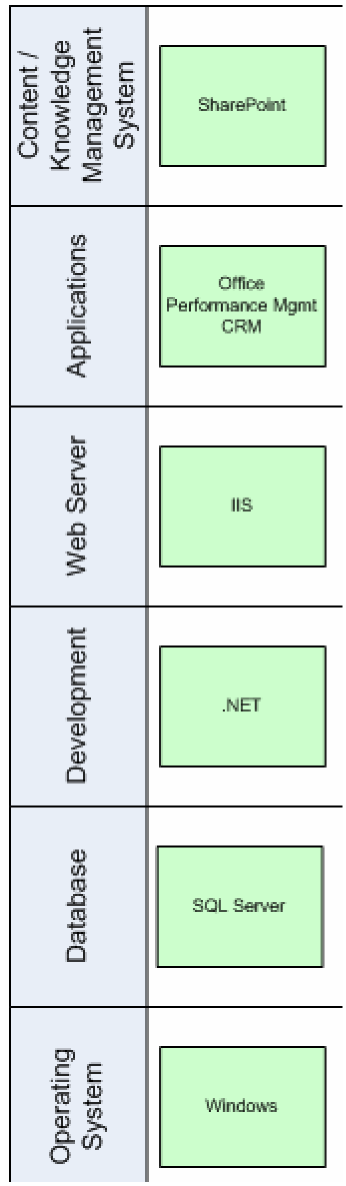


Figure 22: Sample BI Vertical Architecture

Table 21 displays BIS themes as developed within BIS. Information is now accessible to a global set of stakeholders due to reduced cost and technology, as well as increasing resource capabilities across the entire organization to achieve competitive advantages. The decision focus based on the information now occurs at an operational or line-level, as well as a strategic level, for both short and long-term decision making. This is an important distinction within BIS vs. prior decision support systems, as the systems are accessed by and provide capabilities for virtually all stakeholders instead of executives or a select group only. While executives may have the greatest influence in decision making, it is also the day-to-day operational level employees and various stakeholders who also make decisions that can influence the organization and other stakeholders. It is this access to information that allows learning to occur.

BIS Democratization is a key component to the impact of BIS over prior support systems. The keys to democratization include low cost, web accessible, culture, scalability, and customizability. BIS system cost has been lowered significantly, allowing mass adoption of systems. Costs now range from no cost, to several hundred dollars per user, in line with licensing costs for other organizational applications, and a small portion of total employee costs. The second factor is web accessibility, this puts BIS within reach of most users given the familiarity with web pages and overall interactivity, vs. a custom desktop application with non-intuitive interface. The third is culture, company cultures are increasingly computerized and utilize information systems throughout the workforce. Fourth is scalability, the ability to easily add new users and areas, allows easy roll-out to increasing larger sets of employees. Last is customizability, or the ability to tailor the BIS software to the entire set of employees without incurring significant additional costs, which allows continued use of investment, and avoids several packaged application supporting each area. The table below shows the key components of BIS systems, and displays the percentage of active users accessing each component. While the vision of BIS is 100% user adoption, there are still specialized aspects of BIS such as database management where users may not need to use or tools have not yet been tailored appropriate for use or made relevant for all end-users. The BIS was developed with the application layer accessible and presented to all users, through which various BIS components were made available. Greatest percentage access took place through content and knowledge management components such as RSS feeds, announcements, libraries, wikis, contacts, help files, and localized site information. As the tools become more specialized, the percentages decrease, for example 38% of users accessed performance management components such as scorecards and dashboards, and 25% generating self-service ad-hoc reports. The smallest percentages were analysis and DBMS components with 4% and 1% respectively. As these components were available to only a few users for security and skill set reasons. However these uses were made available through the front-end UI. For example, database performance tuning and logical setup was only accessed by a few users, though all users benefited from those components. Likewise, analyses were conducted by a few dedicated users and posted to a knowledge base for access by all users.

Table 20: BIS Components Access

BIS Component	**% Users**
Knowledge Management	100%
Content Management	100%
End-User Tools	100%
Performance Management	38%
Querying / Reporting	25%
Analysis	4%
Database Management System	1%

It is important for users to be confident in the information and the resulting decisions and mental models that are generated in response to the information. Trust is a major factor in the routine use of a system, and information quality plays an important role. The information scope can be broad, encompassing all aspects of the organization at once, or drilling down to a specific function or area, this information drill-through is also described in the level of aggregation, which begins at the lowest level of grain, which allows end users to drill-up or drill-down on required information. The information is also accessible throughout all points in time, including historical data, present data, and future data by means of predictive modeling. Information currency is improved due to operational requirements of real-time monitoring of activities. Persistence is the ability to retain relevant information over the required timeframe, and is achieved through updates and system archiving capabilities. Information is utilized to generate more frequent decisions, which allow the firm to more dynamically adapt to the changing environment, with many decisions occurring in the process of daily activities with little formality. In addition it allows information to be used to supplement individual experience to empirically demonstrate the decision outcome or expected path. The feature set within the BIS is an important contributor for the set of stakeholders to produce the required information. In other words, allowing the user to answer the question, or answer new questions previously not thought of. Key within the set of variables is the analysis capability. These analysis capabilities may include advanced data mining features or simple intuitive reporting capabilities.

Learning capabilities are expanded throughout the entire organization, which allows all users to contribute to competitive performance and quality instead of only select users previously. Learning at individual, team, and organizational levels was found to form significant relationships with competitive performance and being a quality healthcare organization. While mental-model building was previously found to impact competitive performance, mental-model maintenance through use of BIS is also found to impact competitive performance, with mental models included as variables within organizational learning. While executives may be interested in long-term competitive performance and quality achieved through mental-model building, management staff and professional employees are interested in short-term performance goals and quality improvements achieved through mental-model maintenance. Combined these are seen to positively improve the short and long-term sustainability quality and performance of the organization, with BIS providing the information quality and performance management capabilities to drive the organization forward.

Table 21: Business Intelligence System Themes

Theme	**DSS**	**ESS**	**BIS**
User Base	Select	Executive	Global
Decision Focus	Strategic	Strategic	Hybrid
Scope Focus	Narrow	Narrow	Broad
Aggregation	Detailed	Summarized	Drill Through
Time	Historical-Future	Historical-Present	All Time
Currency	Archived	Near Time	Real Time
Learning	Individual	Team	Organization
Persistence	Short Term	Mid Term	Long Term
Decision Frequency	Infrequent	Occasional	Frequent

7.3 Learning Implications

The majority of learning is categorized under maintenance learning, and involves daily and short-term tasks or objectives, and occurs as single-loop learning, with effectiveness at incremental improvements. Single-loop learning is separated from organizational learning which involves double-loop learning. Anticipatory learning deals with proactive and strategic learning to target future issues or opportunities. Crossover and utility tools are likened with best practice approaches to allow both anticipatory and maintenance learning through active participation [102]. BIS incorporates the varying categories of tools, to allow multiple forms of learning to occur in parallel. To achieve maximum effectiveness BIS strategies and roll-out solutions should incorporate a comprehensive toolset aimed at supporting and facilitating learning across multiple levels. The importance of learning is critical for a firm to achieve sustained success, even seemingly trivial tasks should be learned by employees, reinforced, and improved. Learning should be tied to an individual's goals or objectives and evaluated as part of the formal review process and continually reinforced at an organizational level. The figure below lists the BIS components associated with each learning tool.

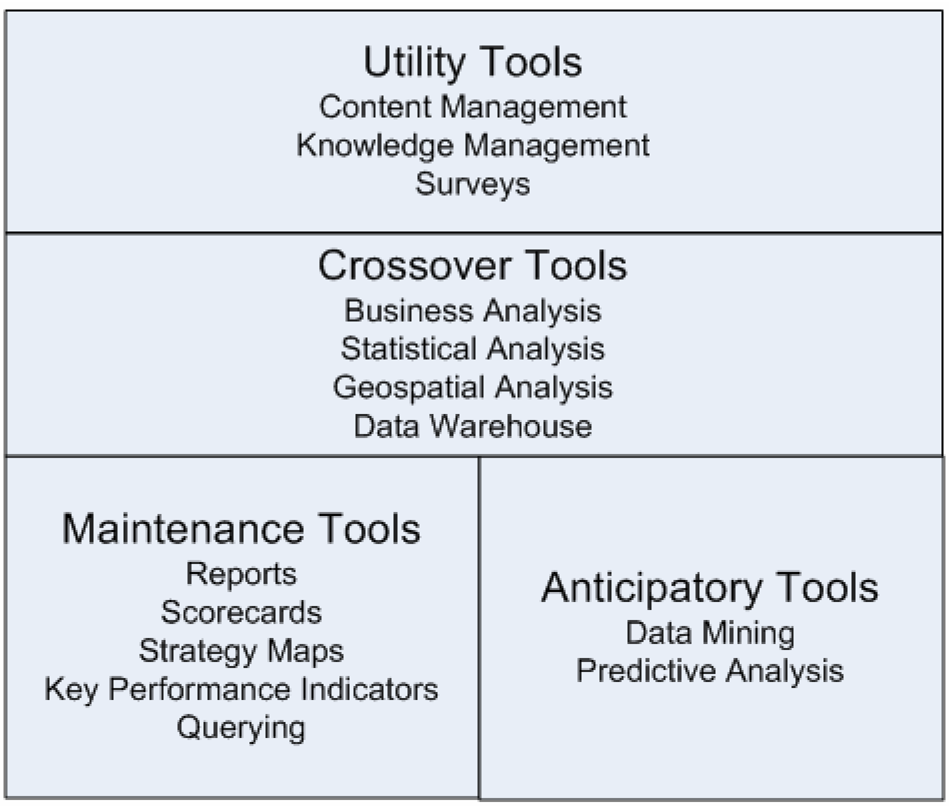


Figure 23: BIS Learning Tools

Individual learning or personal mastery is one's intrinsic motivation for learning and development. Individual theories and models of the world are part of an individual's work and mental models. This form of internal motivation is more effective than other types of external motivation in learning. An individual vision can also lead to a shared organizational vision by working with and motivating others. Individuals utilize mental maps to work through complex environments and situations, but these mental maps are defective in part, and must be developed through learning. Organizations are only able to learn through individuals, which must continually challenge themselves and one another to learn. An organization can build a culture which promotes individual learning, through training and value creating environment [103]. CFT describes the individual learning which occurs in complex domains such as healthcare. Maintenance and anticipatory BIS tools provide the framework for mental model building and mental model maintenance which form individual learning. As a specific example, an end user may review a daily scorecard which monitors and reinforces activity conduct during that particular day. The user may also employ predictive analysis capabilities, in the form of an anticipatory tool, to determine which patient's may require additional preventative services than were provided. The user is then able to identify various root cause components to improve routine completion within the process, and build existing mental models for affected stakeholders.

Shared visions by an organization are a form of organizational community and goals. These shared visions are critical to achieve organizational learning. A majority of visions are created by an individual or small group of individuals and mandated to the organization, rather than being reflections of each individual's vision. A shared vision can be incorporated into the organization's products and services which are improved through BIS capabilities and learning [103]. The key learning theory around shared vision is situative learning theory, in which communities of practice are formed to foster learning and development. Crossover and utility tools assist with forming theses communities of practice through social exchange and knowledge transfer capabilities provided through the BIS. As a specific example, users are able to search and identify knowledge expertise in a particular subject area, that user is able to contact the user via phone, instant messaging, or email, or through discussion board dialogue where other users are able to utilize historical knowledge for their own learning and development.

Table 22: Learning Themes

Learning / BIS Tools	Maintenance	Anticipatory	Crossover	Utility
Individual Learning Mental Model Maintenance	X		X	X
Individual Learning Mental Model Building		X	X	X
Organizational Learning Shared Visions			X	X

7.4 Healthcare Implications

Within healthcare, quality is an important aspect from improving delivery of services, to patient care, and quality of life. In this study, healthcare quality was found to have a significant relationship with competitive performance. The combination of employee, customer, and shareholder satisfaction along with quality healthcare services, contributes to overall competitive performance of an organization. BIS information quality contributes to learning and resulting quality of the healthcare organization through quality monitoring and predictive capabilities delivered through dashboards, scorecards, and reporting functions.

To achieve competitive performance, healthcare organizations must support quality programs and organizational learning vis-à-vis BIS. It is important to note that through BIS information quality, individual users can contribute to a firm's competitive advantage. This is important as earlier notions of the resource-based-view of the firm held that only managerial talent led to competitive advantages. This necessitates the need to retain key healthcare staff both at professional contributor and managerial levels. The knowledge based theory of the firm also identifies that the knowledge developed and captured through BIS and learning, can create a significant resource leading to sustained competitive advantages.

The healthcare industry must resolve conflicting objectives between competitive performance and quality. For example the desire to return shareholder investment through profit and revenue increases, must be balanced with the desire to improve quality of care and outcomes for patients. BIS permits the realization of both objectives through improved tracking of information and decision making capabilities. Recently significant investment in healthcare information technology, a sub-component of BIS has allowed patient centered tracking with access by patients and providers to improve information flows. Technology has also allowed pay for performance programs, in which providers are given incentive pay to promote best practices of improved quality and cost of care. The conflicting objectives are brought to some resolution through use of BIS, in which accountants and clinicians can both reach consensus on appropriate results. The growing amounts of information and use of healthcare information technology, requires BIS capabilities and improved information quality in order to ensure both quality and performance objectives are met or exceeded, and for the healthcare organization to remain or move into an industry leadership position.

Healthcare information security and privacy is also another key area which has implications for the electronic storage, usage, and transmission under BIS. As electronic information becomes more prevalent, threats to individual rights are privacy present themselves, as traditional safeguards are no longer applicable. The Health Insurance Portability and Accountability Act (HIPAA) of 1996, introduced security and privacy rules to safeguard privacy and ensure security of information. The privacy rule encompasses oral, written, and electronic forms of information, and creates penalties for inappropriate usage based on established guidelines. The security rule encompasses electronic forms, and protection against unauthorized access. The compliance categories of protection include administrative, physical, technical, organizational, and policy safeguards [104].

7.5 Practical Implications

Stakeholder demands have required organizations to implement quality services, products, and programs. For organization wide total quality, cross-functional management and communication structures are required, in order to bring together competing priorities, and range of individual abilities to achieve set objectives. When total quality management fails, it is typically due to the missing complementary resources that are required. In order to succeed and achieve organizational quality strategies, strong backing by top management, information systems, and a stakeholder focused culture are required. Additional requirements include application of quality assurance and improvement to all organizational subsystems, such as individual department or business process areas. Organizations must link strategies, actions, and measures in order to achieve quality benefits. Performance management components should be based on the organizational success factors, and tracked systematically [22].

HIT allows business intelligence and performance management capabilities to determine the best course of action to address stakeholder requirements. Literature has shown the right information in the hands of patients, providers, case managers, and others leads to improved quality. Recent driving forces by technology-enabled stakeholders, have created the demand for up to date information, and self-management, ultimately leading to active management of improved quality [57].   Future directions include developing a HIT process framework from an inter-organizational standpoint, and longer-term annual comparison periods for measuring and ensuring sustained improvements. Other steps involve descriptive analysis and modification of requirements based on the specific vantage points such as a payer, provider, and patient.

The need to set HIT as a designated quality project, along with management support is critical to overall success. Healthcare organizations must continually adapt and improve in order to be successful. HIT can be utilized to aggregate and analyze information to improve decision making and support. A process framework which includes the aforementioned HIT techniques is described below for establishing organizational quality management improvements.

The first step in the overall HIT quality improvement plan is to gather data for baseline measurement. This data may be collected through a variety of sources, such as financial, clinical, or operational, depending on the measure. Most measures are typically collected monthly such as financial measures, although frequencies also can include daily, weekly, bi-weekly, quarterly, annual, and other special cases. Quality measure baselines can be established from initial period data, while other measure baselines may be established from common industry knowledge/standards.

Quality measure data is able to be collected in a data warehouse for historical and future extraction, trending, and data mining. Information can be displayed through a web-based user interface, with the ability to filter for varying time periods, drill-down to varying levels of detail, and for viewing historical comparisons. Improvement targets and overall goals are established for tracking progress against measures, with visual cues provided.

Quality goals should be set at an organizational, state, business unit, or other lowest level of the organization, and include Shareholder, Customer, and Employee satisfaction targets relevant to the organization. Quality goals should generally have a fixed target, percent, or relative improvement over baseline to measure progress towards goal. Items and progress towards goals can then reviewed on a monthly, quarterly, and annual basis to identify key improvement areas.

Most goals are set for an annual basis, with periodic target markers to track interim progress throughout the year. Audit and progress reports are delivered monthly to identify measures not meeting targets and additional quality issues. Other on-demand reports are made available for tracking history and overall value presentation. A sample project plan is presented below in Figure 24. This plan follows an iterative methodology, in which incremental value is delivered, with multiple iterations able to occur simultaneously, and in cyclical order.

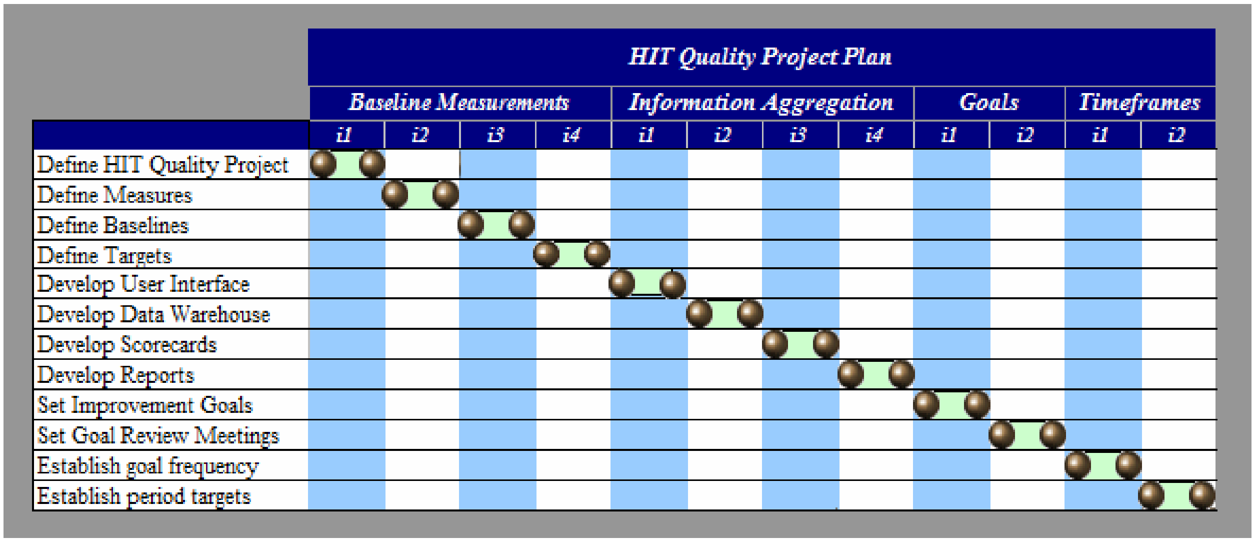


Figure 24: HIT Quality Project Plan

7.6 Lessons Learned and Identified Best Practices

7.6.1 Collaborative Culture

Team work is an important aspect throughout any implementation project. This requires close cooperation between all department areas and business and technical teams, including top management, consultants, end-users, and vendors [105]. Aligning resources with business strategies is also important, as typically there is limited alignment between BI strategy and business strategy [36]. Organizational learning through shared visions and commitment to learning is an important aspect to collaborative culture and can be achieved through team work and alignment between units in support of a common objective and set of goals.

H1: *There is a positive relationship between collaborative culture and implementation success*

7.6.2 Communication

Wide information sharing and understanding must occur by all stakeholders throughout the implementation stages and beyond. Communication should start as early as possible to gain organizational understanding and acceptance [105]. Beyond development of BI and user training, the vision must be marketed and communicated. The BI applications must be viewed as mission critical and all users share that vision [36]. Communication should be started early in the form of several announcements and organizational newsletters, including email, meeting, and Intranet announcements. Kick-off meetings with key personnel and staff resources should also take place, along with regularly recurring meetings.

H2: *There is a positive relationship between communication and implementation success*

7.6.3 Customization

BPR involves rethinking and redesigning business processes to improve key performance measures such as cost and quality of service. Most organizations are required to modify their existing business processes to fit the application software as a way to limit customizations [105]. Arnott describes this similarly as the degree of fit between the organization and the software and hardware [106]. Many times an implementation may not meet expectations, due to an underestimation of change management complexities and encountering resistance to change [105]. In many cases, end users must be trained in the new paradigm after and during BI implementation. Users must also be trained in understanding and adjusting to changes in business processes [36]. BI platforms should be selected which allow for customizations to occur dynamically through the user interface, this resolves prior system issues which occurred at time of upgrade of customized applications or modules. The flexibility of most BI platforms allow for customizations which previously were unavailable in the scope of a enterprise application.

H3: *There is a positive relationship between customization and implementation success*

7.6.4 Project Management

Organizations should use s structured and formal approach for BI projects. Many projects fail to adequately account for organizational requirements, resources, and funding necessary to support a successful BI implementation [36]. PM includes coordinating, scheduling, scope, and monitoring activities and resources in line with the project objectives. PM is also responsible for the overall implementation process and developing organizational support. The DW/BI systems should be developed iteratively building to a complete application set. [105, 106]. Agile methodology was adopted, having a formal project methodology and a formal project management office for oversight and project tracking is critical to the project's success. It is important to establish critical success indicators and metrics from project inception, to ensure expectations are met and exceeded. To allow improved deployment speed, an iterative methodology with rapid prototyping should be employed. Parallel user sub-groups should be established to allow continuous feedback from rapid prototyping and to reduce periods of inactivity.

H4: *There is a positive relationship between project management and implementation success*

7.6.5 Resources

Resources can include financial, people, hardware, software and time for project completion. It is also important to fund new activities required as a result of BI implementation such as meta data management. Resource issues often have a negative impact on implementation success [5, 36, 106]. Consultants are often required due to a knowledge gap and complexity of new systems. User involvement can occur through requirements gathering, implementation participation, and use after go-live [105]. Dedicated resources should be assigned to avoid inevitable competing projects and priorities. Dedicated consultant resources should be allocated to improve timeline and knowledge transfer for new technology areas. Though consultants should only be utilized as a temporary solution, as knowledge-loss occurs with continued usage. Dedicated department or area based resources should be assigned for local subject matter experts and knowledge diffusion.

H5: *There is a positive relationship between resources and implementation success*

7.6.6 Top Management Support

Top management provides the required resources in a direct or indirect manner through financing, as well as the power and support. Top management is also responsible for setting a clear direction, overall project objectives, project guidance, representation, and establishing these throughout the organization [105, 106]. Sponsorship across the entire management team, allows others in the organization to support the project through reducing political resistance, and facilitate participation. Top management support must include top management champions and are viewed similarly [5]. All top management should be advised of the project by the sponsors, and any issues or concerns addressed initially. It is vital for the sponsors to continually update top management early in the project, and as components are released to end-users.

H6: *There is a positive relationship between top management support and implementation success*

7.6.7 Training

Training end-users is important to improve knowledge and appropriate use of the system. General BI concepts, components, demonstration, and use are key training areas. Training should also include process changes and overall flow of information and integration [105]. Training also includes the standards and policies that must be followed for the new BI applications, to optimize use of BI by end-users [36]. Training modules and materials should be developed prior to the initial go-live, along governance plans, such as best practices, content and technical standards, and policies and procedures should be developed for training purposes. In addition, proactive monitoring of training issues should be immediately addressed to avoid long-term paradigm creation in early stages. New users should be required to take established training and existing users on an annual basis and directed to the training materials as questions arise.

H7: *There is a positive relationship between training and implementation success*

7.6.8 Vertical Architecture

In prior BI implementations multiple vendor solutions required purchase, as one vendor did not provide a fully integrated solution, also other companies chose a best of breed approach based on vendor offerings. Today, several vendors offer completely integrated solutions with equitable offerings across services. In one survey organizations utilized an average of 3.2 vendors with 8-13 tools. For the small-medium business scenario, utilizing a vertical architecture with a single vendor was identified as a critical success factor. Due to resource and funding requirements, the ability to match expert skillsets with a best of breed approach is not possible. The use of a single vendor also improves delivery time through ease of installation and avoids integration issues that commonly arise when utilizing multiple vendor solutions vendors. Here, a vertical architecture is defined as having a single vendor designed and developed BI platform, which includes Knowledge Management, Content Management, Performance Management, End-User Tools, Querying / Reporting, Analysis, and Database Management System.

H8: *There is a positive relationship between vertical architecture and implementation success*

7.6.9 Perception-Based Success Factors

BI project implementation success is measured through whether the project completed timely, completed on budget, and overall satisfaction with the BI [5, 6]. These measures are survey-based perception measures, a separate set of data-based success measurements are also included as a component of the case study. The table below displays the summary of supporting works for construct and hypothesis development.

Table 23: Summary of Supporting CSF Works

	Wixom and Watson (2005)	Bhatti (2005)	Williams and Williams (2007)	Howson (2008)	Arnott (2008)	Case Study
Implementation Factors						
Collaborative Culture		X	X			X
Customization		X	X		X	X
Communication		X	X			X
Project Management	X	X	X		X	X
Resources	X	X	X		X	X
Top Management Support	X	X			X	X
Training		X	X			X

Vertical Integration				X		X
Success Factors						
Perceived Success	X			X		X
Timely Implementation	X			X		X
Satisfaction	X			X		X

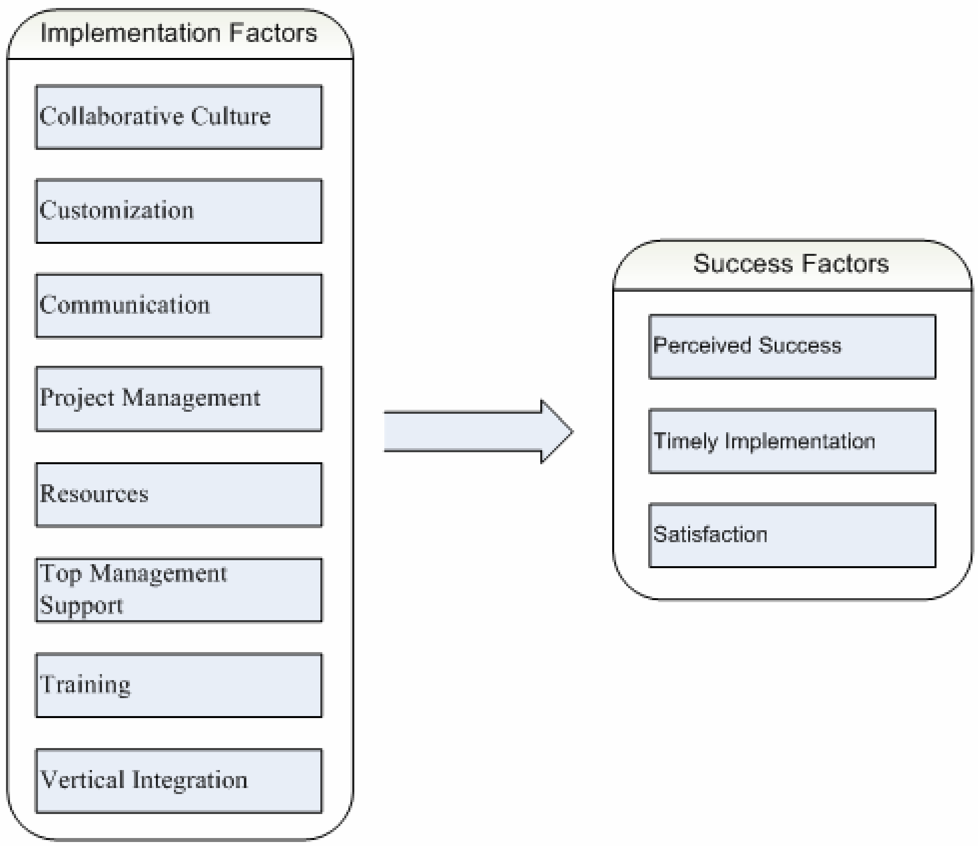


Figure 25: BI Implementation Success Model

A path analysis is employed using SmartPLS 2.0 software to analyze the results and determine model fit [100]. A model with significant loadings is developed. Significance of relationships was determined between implementation factors and success factors. The final model specification includes the supported paths, all paths were supported for significance at p = 0.01. Results showed that 73.8% of the variability in implementation success is explained from the model.

Table 24. CSF Measurement Model Quality

	AVE	Composite Reliability	R Square	Cronbachs Alpha
Implementation Factors	0.57986	0.90581		0.878317
Success Factors	0.66762	0.922954	0.738381	0.899059

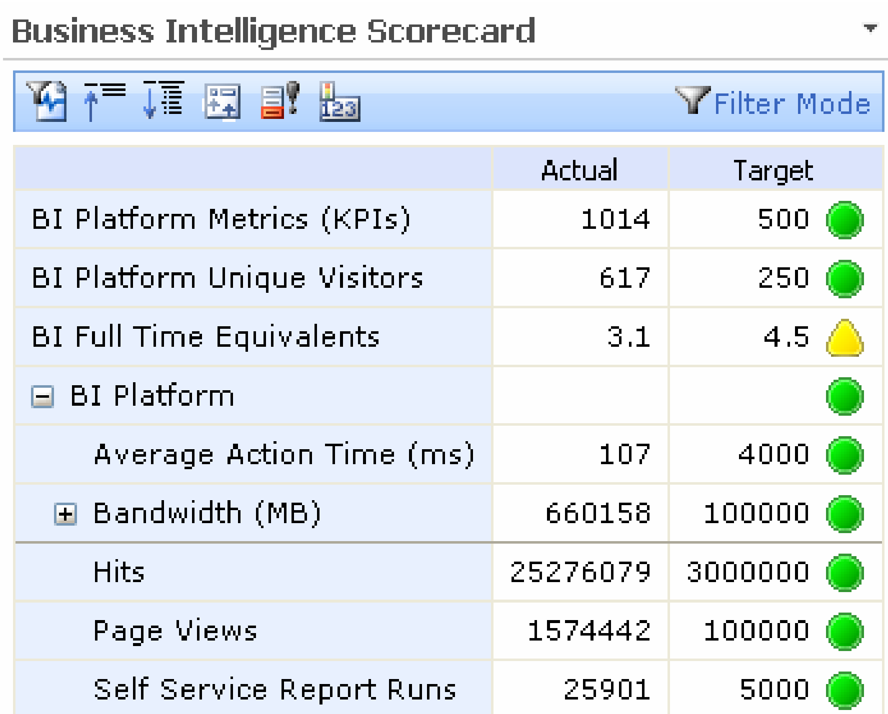
The table above displays the quality of the model. The average variance extracted is indicated by the column AVE, and is the average communality for the latent factors in the model. AVE is utilized for convergent validity, and should be greater than or equal to 0.5, which the latent factors exceed. Composite reliability is also utilized as Cronbach's alpha commonly underestimates or overestimates reliability. Composite reliability follows similarly to Cronbach's alpha, with 0.80 to be considered good, 0.70 to be considered acceptable, and 0.60 to be considered for exploratory requirements. Composite reliability exceed 0.90 for this model. R-Square displays the effect size measure, and is not shown for exogenous constructs. An R-Square of 0.67 is considered substantial, 0.33 considered moderate, and 0.19 considered weak. The R-Square for this model is 0.73. Cronbach's alpha should be equal to at least 0.80 to be considered good, 0.70 to be considered acceptable, and 0.60 to be considered for exploratory requirements. For short scales, Cronbach's alpha may be biased, this study utilized 7 point scales for all questions measured, and Cronbach's alpha exceed 0.80 [96, 100].

7.7 Success Components

Given the complexity of most system implementations, no single measure exists for Business Intelligence success. As a result, various measures including tangible and intangible measures are utilized to determine success, including perception-based measures, return on investment, system response time, report generation, among others [6]. Beginning with the initial go-live, identified key metrics were tracked to gauge BI initiative success. Based on industry literature and baselines, many of the metric targets were set higher in an effort to make the most of the information systems investments. The specific measures for tracking are presented below, and were populated in scorecard format for improved tracking and support of BI implementation success as shown below.

7.7.1 BI Platform Metrics (KPI's)

In order to improve business performance, make data more accessible, support key areas, improve our mission as a quality organization, and present data in various visual ways, a comprehensive performance management component of the BI initiative was started, and resulted in definition, development, and presentation of over 1,000 Key Performance Indicators in Scorecard, Dashboard, and Report formats. Once a full year of data was captured, these KPI's were later reduced to focus specifically on those which accounted for the greatest contribution to key goals.



	Actual	Target
BI Platform Metrics (KPIs)	1014	500
BI Platform Unique Visitors	617	250
BI Full Time Equivalents	3.1	4.5
BI Platform		
Average Action Time (ms)	107	4000
Bandwidth (MB)	660158	100000
Hits	25276079	3000000
Page Views	1574442	100000
Self Service Report Runs	25901	5000

Figure 26: Business Intelligence Project Scorecard

7.7.2 Unique Visitors

In surveys measuring successful BI implementations ~18% of total users regularly utilized the BI platform, with consideration that roughly only 50% should have access, however to be successful the objective should be 100% [6]. The universal adoption goal of global enterprise adoption, which includes all stakeholders, was made at the outset of the project. The specific goal, was based on employee totals and represented approximately 100% of employees having accessed the BI platform within the current month, and was effectively reached less than one year after initial go-live, with extension to additional stakeholders such as board members and consultants which increased the total.

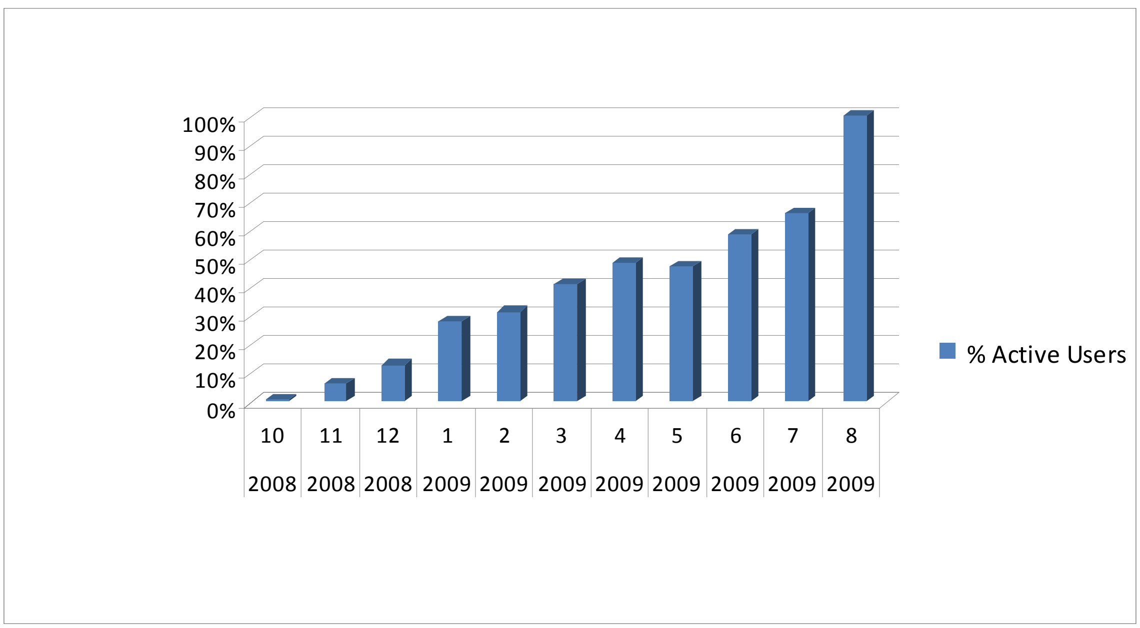


Figure 27: Percentage of Active Users as Number of Employees

7.7.3 Average Action Time

As a measure of system reliability, and throughout increases in users and usage, average action time, which measures the overall system response in milliseconds, remained ahead of acceptable response times and user performance requirements and expectations, with a target of 4000 milliseconds as measured through system logging. Sufficient capacity was added during the planning stages, in order to allow long-term growth projections to occur without impacting system performance or requiring re-architecture or upgrades to accommodate increased usage.

7.7.4 Usage

As a proxy for usage, and to compare relative usage between individuals and departments, a combination of visitors, bandwidth, hits, page views, and self-service report runs was developed, and presented in summary scorecard form. In addition detailed usage reports were supplied to individual departments on a monthly basis, along with individual user detail reports on demand such as a *My BI Usage* report. Visitors included unique visitors based on named logon, and visits included unique daily visits with a maximum of 1 per day. Hits included the total number of web part/content components loaded. Page Views included the total number of individual page views. Bandwidth included total server sent and received megabytes utilized. Self-Service report runs, included those reports scheduled for automated delivery or those which were invoked by the individual user, entering various parameters for selection and on-demand generation.

7.7.5 Release Management

Following an iterative methodology was identified as a critical success factor, which allowed for continuous release of key features to additional areas approximately every month. Release management for each of the 24 project iterations were also tracked through the scorecard for current status. These iterations included department releases, as well as key functionality such as performance management, content management, KPI sets, data warehouse features, along with other capabilities.

7.7.6 Departmental Survey

In addition to key success metrics above, a business-based survey was conducted to gauge overall improvements as a result of BI investment as part of a semi-annual department survey. The survey graph below displays overall improvement relative to BI contribution prior to standardized BI platform implementation and after implementation. These areas included perceived BI contribution to performance, sales, ease of use, information accuracy, information currency, information accuracy, information presentation, and overall stakeholder satisfaction. The results were scored as a percentage scale score, with 100% being the highest possible score. Significant improvement is shown within all established critical success factors between February 2008 and December 2009 comparison period, or pre and post-implementation.

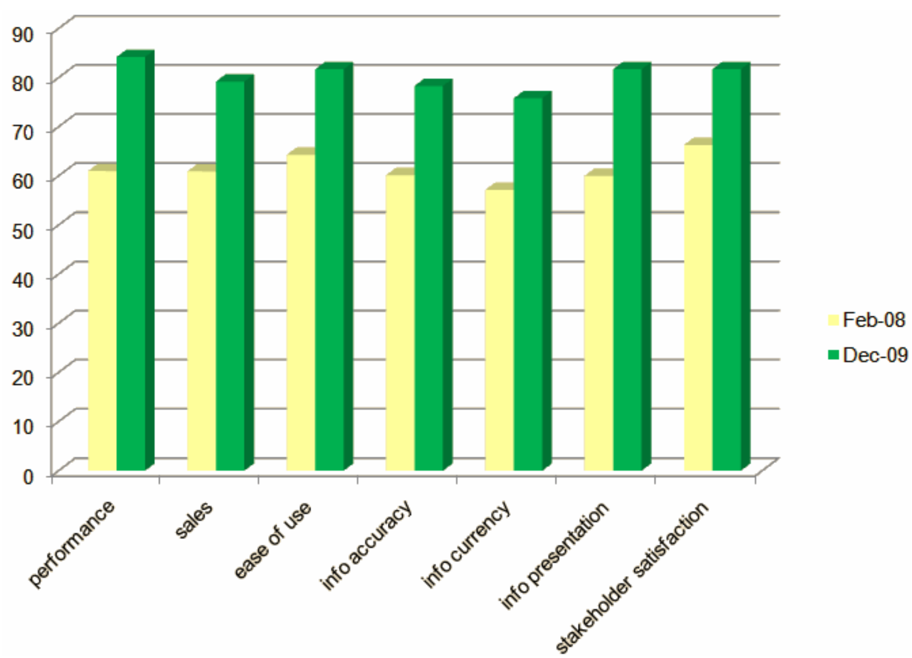


Figure 28: BIS Contribution Pre-Post Implementation for Select Measures

7.8 Return on Business Intelligence Investment (ROBII)

Business Intelligence is a critical component for organizations that want to compete in today's economic climate. As an organization progresses in Business Intelligence maturity, the value of its BI activities expands. Successful organizations increasingly utilize analytical approaches to identify and enact modest improvements that increase profitability and return on business intelligence investments (ROBII). Most organizations do not complete a formal ROI due to difficulty in calculating savings and avoidance figures, or failing to capture throughout and beyond projection completion. For those with calculated return on investment, these have ranged between 300% and 2000%, with typically less than one year payback [5, 6, 36, 107]. Cost-savings are presented here in areas including implementation, support, licensing, storage, ITS, productivity, training, and end users are outlined and summarized in terms of overall return on investment for years one following a full year including implementation, and projected out in years two through six. Year one ROBII is 1419%, with years two through six between 815% and 928%. Year one has a greater savings percentage due to implementation cost savings, with future years at a standard growth rate. Cost savings can be greater enhanced through improved levels of growth and capabilities.

Table 25: Return on Business Intelligence Investment Components

ROBII Category	ROBII Component
Technical Savings	Implementation costs
	Support and maintenance costs
	Licensing costs
	System training costs
	Storage costs
	Lower service desk support costs

	Lower ITS support costs
End-User Savings	Increased end-user adoption through system utilization
	Greater productivity among end users
	Faster and more effective responses to organizational changes
	Faster employee transitions to new jobs, roles, and responsibilities
	User training costs
	Performance Management

7.9 CSF Key Findings

The first key finding is the identified implementation construct addition of a vertical architecture, particularly for the small-medium business (SMB) scenario. A vertically-integrated architecture improves the implementation timeline and required resource base for implementation success. The second key finding is around establishing a collaborative culture to promote organizational learning capabilities. This extends previous notions of team work and business-IT alignment, and is necessary to support adoption and use of BIS. Third involves implementation success outcomes when democratization or universal user adoption of BIS has been achieved. In past studies measuring BIS success, only a small portion of users had access to BIS capabilities, it is through the extension of BIS to all users that successful outcomes can be realized. The fourth component includes systematic capture of key BIS metrics to ensure usage standards are met, and tracking these project success factors by utilizing the inherent BIS capabilities. This permits organization-wide tracking and transparent viewing of BIS implementation project status, along with key system indicators. The last component utilizes case study evaluation of identified success factors and develops calculations to demonstrate business value of BIS, through both empirical methods and evaluation of existing success components comparatively, triangulating results to form success conclusions.

There is an importance to identifying universally applying critical success factors, and the ability for tailoring those factors to an individual organization or implementation. However it is the adaptability of the BIS capabilities and the overall project that will ensure successful completion. Other identified areas of study and importance beyond implementation include establishing a competency center to ensure continue usage of business intelligence, stakeholder satisfaction, and decreased costs. Another area is establishing an architecture roadmap for future iterations and system updates, these include enhancements to key capabilities and features, bug fixes, security improvements, and ensured vendor support. A governance plan is also important to establish technical roles, support service level agreements, back and recovery, database and data standards, metadata standards, content branding, life cycle policies, and training.

7.10 Business Intelligence Research and Competency Center (BIRCC)

The BIRCC consists of two main components, the research center and competency center. The research center seeks to develop publication quality research and development. This includes establishing an organization as a leader in research and development, gaining industry exposure through peer review outlets, incorporating empirical methodology for evaluation and improvement, improving understanding of theoretical backgrounds and implications, and citing for proposal expertise and marketing materials. The second component, the competency center consists of operational aspects such as BI program and project management, technical support, training, data stewardship, analytics, performance management, contracts administration, data acquisition, and delivery. The research and competency center components work closely together to provide feedback on current practices, identify future trends and opportunities, and improve overall organizational BI value. Benefits for a BIRCC include increased usage of BI, increased user satisfaction, better understanding of BI value, increased decision making speed, decreased staff costs, decreased software costs. The figure below describes a sample BIRCC structure with the two main components of research and competency center along with key responsibilities and functions, along with overall oversight and core resources team to support the BIRCC [108, 109].

The BIRCC supports itself through cost savings realized by eliminating redundant tools or reducing the overhead of expensive support and maintenance contracts. As the BIRCC becomes more strategic, it becomes more difficult to quantify its intrinsic value, such as measuring improved decision makers. Many Centers demonstrate tangible and intangible benefits and continue to deliver greater value from BI investments. Funding recommendations include listing costs as overhead, then all departments can use the BIRCC services [108, 109].

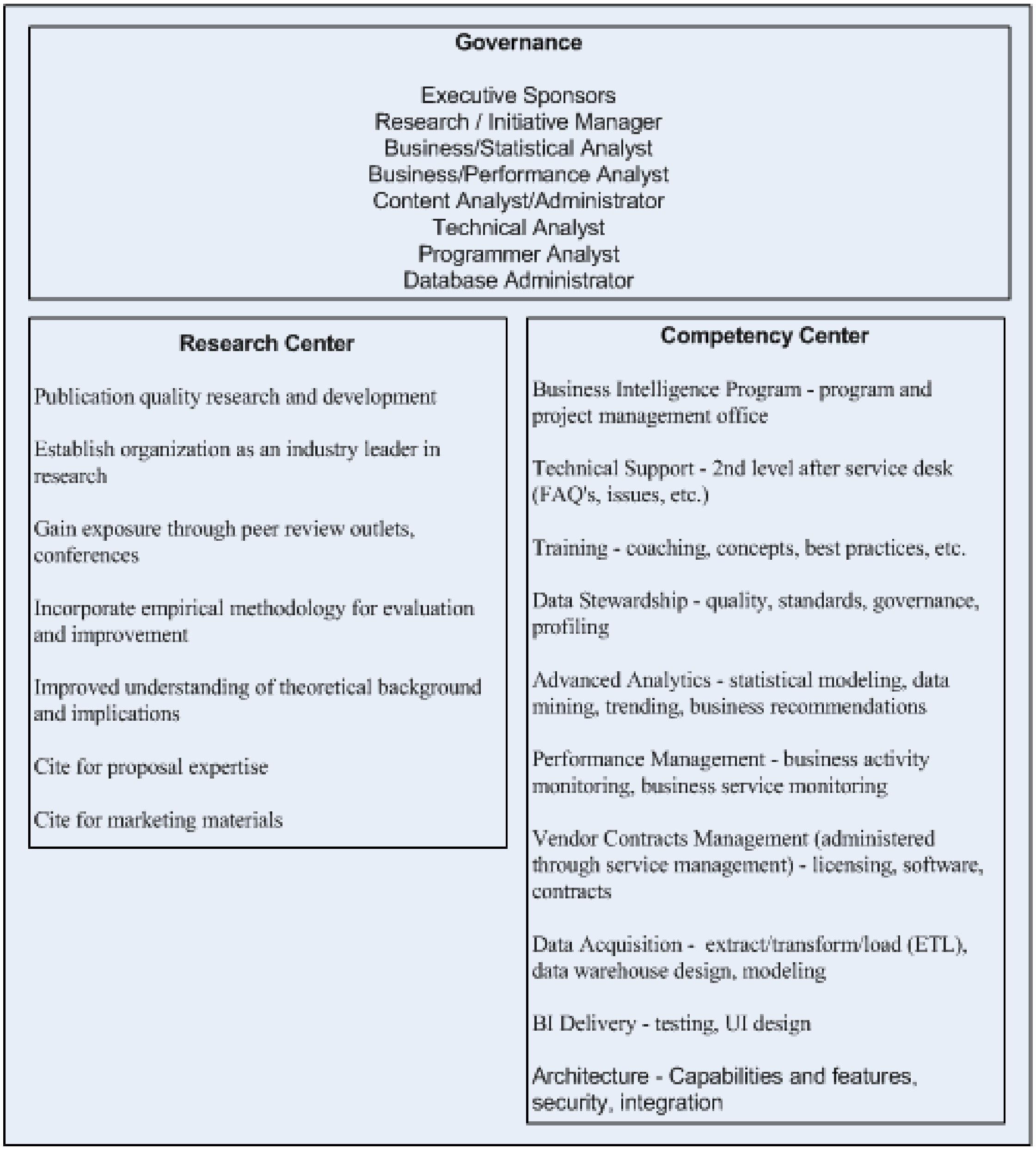


Figure 29: BIRCC Structure

7.11 BIS Governance Plan

A typical governance plan contains both technical and content/knowledge management components. The first step is drafting a governance plan, or utilizing existing plans and adapting accordingly. The governance plan is a guideline outlining the administration, maintenance, and support of BIS deployment. It identifies ownership for business and technical teams and identifies responsibility for various BIS areas. The plan also establishes a set of appropriate use guidelines and mechanisms for maintaining the systems. The governance plan seeks to ensure adequate system management occurs, and minimize risk components such as scope creep or out of control structures. The governance plan requires business and technical skill sets to develop policies and procedures for the BIS in a way that benefits both short-term and long-term objectives. This includes routine day-to-day tasks, as well as strategic initiatives, and involving various stakeholders in the processes. The goals of the governance plan include: establishing the services definition and governing technical and business policies by which the BIS will be run based on the defined requirements, creating a team to govern and support the BIS based on the current services offered, and communicating the initial high-level ITS and business requirements as they relate to the services offered. Key components of a typical BIS governance plan are included below [110].

Table 26: BIS Governance Plan Components

Category	BIS Governance Plan Components
Sponsors	Executive Overview
	Sponsor Signoff and Commitment
Project Management	Project and Operational Management
	Initiative Critical Success Factors
	Service Delivery Goals
	Delivery Requirements
	Content Service Definition
	Team Roles
	Communication Plan
	Business Review Meetings
	Content
Technical	Support Services
	Physical Topologies

	Development and Configuration Application Policies
	IT Governance Definitions
	Security
	Appendix Key Terms and Definitions
	Administrator, Developer and End User Training

7.12 Combined BIS Model Specification

A combined BIS model specification from research manuscript sections is shown below. This includes the various components of the research manuscript, starting with key implementation success factors for BIS, followed by learning antecedents, learning, learning outcomes, and expanded organizational quality discussion on learning outcomes.

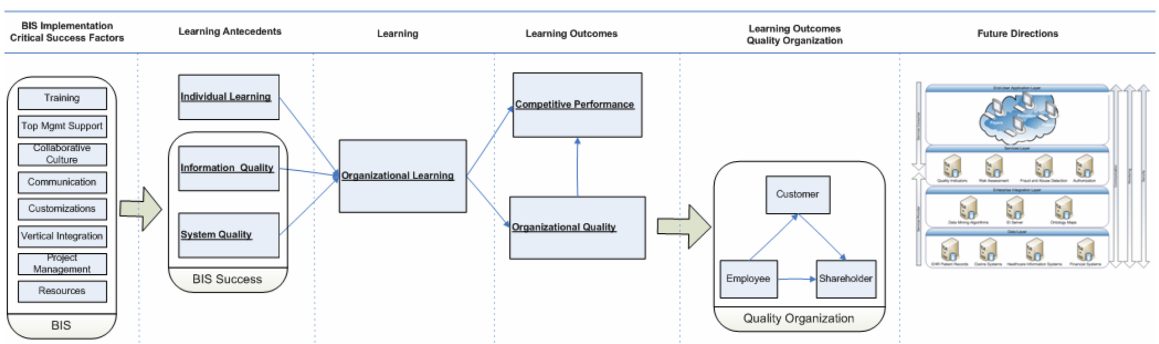


Figure 30: Combined BIS Model Specification

7.13 Limitations

A limitation may be external validity or ability to generalize across time, location, or person. Generalization uses an inductive process to extrapolate beyond the data, where trivial and interaction factors are identified, and attempts are made to close the experiment gap between time, location or person. To improve external validity, this study seeks to model the healthcare industry only, as well as select users who are represented across multiple geographic locations, affiliated entities, healthcare service types, healthcare sectors, and contract types. As several of the measurement items are not readily available externally, and require dedicated healthcare professionals to conduct, a case study is utilized to capture and analyze the required components [111]. Limitations also include a single sample study, to which data driven modifications are made to improve fit. The triangulation methods employed also create some replication difficulty, particularly within qualitative methods, though components and results are contained within the study to outline the mixed-methods portfolio and approach. This model should be completed with additional samples to generalize the approach. This model may also be extended outside the healthcare industry to incorporate other quality concepts in the model.

7.14 Contributions

This research study identifies relationships of BIS on learning, quality, and performance within a healthcare setting. Previous information systems have not demonstrated a link between mental-model maintenance and competitive performance. In addition previous research does not directly address how BIS and learning impact organizational quality or discuss BIS specific relationships specifically within a healthcare setting. This study develops a BIS model for quality and performance when viewed through a learning perspective. The improved model adds explanatory power over prior models, and theoretical contributions to BIS use. The model also includes an important quality component, when used in conjunction BIS, is improved as a result of learning, and quality also adds to the performance of the organization. Practitioner knowledge is improved through use of a case study, and identifies key priorities, IT/business budgeting requirements, success estimation, quality, and performance improvements that are able to be achieved through BIS. Policy knowledge can be gained through healthcare information systems funding, focus of government programs, and overall quality focus of healthcare. Key contributions include:

- Improved explanatory power over prior models
- Significant link between multiple forms of learning
- Quality Organization component added to model
- Significant link between organizational quality and competitive performance
- Quality considerations of varying stakeholders and quality management
- Healthcare implications
- BIS implications
- Learning implications
- Critical success factors of BIS
- Lessons learned for BIS
- Evaluation of ROBII and return on investment calculation methods
- Business Intelligence Research and Competency Center (BIRCC) instantiation
- Governance plan sample components
- Future directions of healthcare BIS services and application portfolio
- BI 2.0 and cloud computing architecture developed

VIII. CONCLUSION

In the competitive marketplace of today, it is vital for healthcare organizations to adopt strategies and information systems which lead to sustainability, improved quality and competitive position. Information quality is found to be a key differentiator in the ability for learning to influence competitive performance. The unique context of healthcare requires an extension over prior information system studies to incorporate additional quality and information objectives. Whereas prior literature failed to find significant links between ESS and mental-model maintenance, when utilizing the same study for BIS we are able to identify significant relationships as a component of organizational learning. This demonstrates the capability of BIS to improve organizational sustainability and lead to quality and competitive performance. The set of BIS components allows organizations to continually improve, and allows information access by all levels of the organization. Possible limitations include sample size or respondents. Future directions include determining fit by industry as well as longitudinal studies to determine if learning of relationships of quality and performance changes over time with continual use of BIS. Additional areas include exploring capabilities by vendors, or comparing systems with enhanced features, such as those found within the next generation of BIS tools, or BI 2.0.

IX. FUTURE DIRECTIONS

As organizations seek to take part in the growing IT services sector, they must develop the appropriate architecture and business solutions which provide meaningful information in real-time. Services definition and improvements to existing systems is an important and growing area of research. An overall BI 2.0 application architecture for healthcare services in the cloud is presented for enterprise integration of information and BIS components, and outlines a portfolio of healthcare applications that can be configured for and consumed by healthcare service users. A sample healthcare data mining service application example is presented for real-time information exchange and support in clinical decision making.

The economy is being transformed into a service industry, with services accounting for 75% of the US GDP, and 80% of private employment. Overall IT services are projected to increase at a 6.4% annual growth rate and value of $855.6 billion through 2010. Organizations that introduce a service-oriented architecture reduce integration and maintenance costs by up to 30%, and it is expected that 33% of business application spending will be on SaaS by 2012 and 40% of capital spending on IaaS by 2011, with spending to exceed $33.8 billion in 2010. A similar report found BI specific SaaS will grow at 22.4% annual rate through 2013. SaaS BI is being utilized during peak demand periods, and for those organizations seeking to reduce on premise costs or who typically do not have dedicated technology staff. IBM, a key player in the services sector continues to grow is service offerings, and is seeking to transform itself into an on-demand service organization, and has extensively studied how those service innovations can lead to sustainability and long-term growth. For business decision makers, the issue remains as to what level of commitment and investment should be made to these new services. SOA have been studied in research, some gaps include how these service capabilities will be used within the business to create value, and how can these structures be created [112, 113].

In 2010, The Department of Health and Human Services' (HHS) National Coordinator for Health Information Technology announced $60 million of funding for Strategic Health IT Advanced Research Projects (SHARP). These special research projects are intended to develop solutions to existing barriers in adoption and use of healthcare information technology (HIT). As a component of the American Recovery and Reinvestment Act (ARRA) the grants are intended to promote the use of HIT to improve the quality and efficiency of health care and create collaboration between researchers, health care providers, and healthcare stakeholders. The key areas of study include patient focused HIT which supports patient care in day to day practice, application architectures to improve health exchange, and secondary use of EHR data to improve quality through HIT [114]. The outlined healthcare data mining services support these key areas, through improved patient care and processing times, enhanced enterprise architectures for information transparency, and second use of data to improve quality of care and operational performance.

9.1 Business Intelligence 2.0

BI 2.0 describes the ways business information can be utilized in real-time, and how BI can be applied to the business events. BI 2.0 speaks to the ability to delivery self-service tools and mash up capabilities to end-users in real-time. In addition increasing generations of technology users are demanding these capabilities. Real-time data from widening sources is also generating demand, and is often displaces the centralized data warehouse concept, giving way to context and real-time information from all operation systems, logs, databases, and a wide variety of other sources [115, 116].

Organizations have initiated data warehousing web services, however this data is often not in a real-time state for in process decision support. BI 2.0 processes events in memory in line with the business event. The main events are comprised of XML messages, which embed within business processes for real-time analytics vs. batch for business events can start immediately. Most of these events are automated, or alert the user for a specific action. BI 2.0 utilizes middleware for in process analysis compared with historical data. Real-time demands require software applications that are event-driven, and with real-time data that uses service oriented architectures (SOA), which are loosely coupled and interoperable, enforcing a standardized application integration [115].

Cloud computing provides scalable and virtualized services to the end-user via a simple web browser. A third-party manages the computing infrastructure, and provides the software as a service (SaaS). Salesforce.com, Google Apps, Amazon, and Facebook provide have cloud computing offerings. Cloud computing allows organizational to reduce IT capital costs, and buy computing on an as needed basis. There are economies of scale through shared use of systems and resources by multiple customers. Cloud computing reduces the entry barriers by eliminating software distribution and site installation requirements. This also permits organizations to develop new business models and sources of revenue through on demand services [117].

9.2 Enterprise Integration

Enterprise Information Integration (EII) describes the integration of various data sources into a unified form without requiring all sources be contained within a data warehouse and also integration complexity reductions [118-120]. The enterprise unified view must consume data that is available real-time via direct system access, and semantic resolution must occur across systems. Semantic integration, also known as ontology, is a higher level natural language approach to combine differing pieces of information together, and in support of real-time events. A semantic information model can be constructed using Web Ontology Language (OWL) developed by W3C. The relationships and rules of the data are contained with the model, which the OWL inference engine can read and intelligently integrate the information [119, 121].

Real-time EII begins with SOA, as the access point for all systems through web services, and XML as the data representation [115, 121]. SOA promises improved agility and flexibility for organizations to deliver value-based services to their customers. A service is the application of knowledge for co-creation of value between interacting entities. Service systems involve people, technology, and information. Service science is concerned with understanding service systems, and improve and design services for practical purposes. SOA includes Web service, technology, and infrastructures, and is a process that add value, reuse, information, and overall value to the business. SOA provides a commodization of hardware and software providing organizations with improved architectures and which support IT service flexibility. The SOA approaches are utilized to develop SaaS from IaaS [112].

Most real-time architectures consist of the required data sources and a virtual or mediated data schema which is then queried by the end user or application. The systems are typically build on a XML data model and query language. EII reduces data access time, while Enterprise Application Integration (EAI) allows system updates as part of the business process to occur. Both these technologies are utilized as a best practice and combined into the concept of Enterprise Integration (EI). The EI architecture supports heterogeneous data sources such as relational and non-relational databases, flat files, XML, transactional systems, and content management systems. Information transparency is provided through the virtual data access services layer which permits real-time programming services. This architecture adheres to SOA, where business processes exist as distinct services which communicate through known interfaces. This also helps promote code re-use and more flexible IT infrastructure by allowing focus on business logic, and leaving the data tasks to the EII layer [118-120].

9.3 Healthcare Applications

Healthcare organizations are increasingly investing in data mining services to improve quality, service, and cost [122]. Several healthcare data mining applications are available for building a comprehensive BI 2.0 application portfolio, allowing end-use access without dedicated systems and at a reduced cost to improve value to stakeholders. Many of the healthcare service components currently suffer from lengthy delays and additional stakeholder requirements, which limits real-time information accessibility for decision making and improvements. The table below describes the set of healthcare service components, each with the specified healthcare requirements and improvements objectives, along with current information and decision lag time, common data mining methods utilized, and supporting works.

Table 27: Healthcare Data Mining Applications

Healthcare Services Component	Healthcare Requirements Need	Lag Time	Data Mining Methods	Supporting Works
Risk Assessment	Consumer driven plan selection complexity	Monthly	Clustering, Regression	Cumming et al. (2002), Rector et al. (2004)
Prior Authorization	Cost, Paper/Fax processes	3-4 Days	Decision Tree	Moeller (2009)
Fraud Detection	Fraud prevention, detection and diagnosis	Annual	Neural Network, Classification Tree, Regression	Viaenea et al. (2005); Liou et al. (2008)
Quality Indicators	Quality of care improvements	Monthly	Decision Tree	Chae et al. (2003)

Quality improvement approaches have been adopted within the health care industry in attempt to improve quality of care. Most of the activities to date have focused on manual activities without a direct link to the data within the healthcare information system. Support systems can provide patient outcome information and clinical pathways to support patient care and factors influence quality and treatment. Data mining which allows for knowledge discovery from large sets of data can be used to identify patterns or rules to improve healthcare quality. Patient characteristics including age, gender, department, disease class, and quality indicators were utilized as part of decision tree analysis to determine inpatient mortality factors. An index score was developed to identify how inpatient mortality rates compare to overall proportions, and which segments to focus on [123].

Risk assessment utilizes methods to assess relative risk of individuals within the population, with the relative risk predicting costs. The assessment may be carried out utilizing various forms of data and typically includes claims, pharmacy, and self-reported survey information. This information has been utilized by the federal government to adjust payments to health plans, by employers in determining employee contributions to health coverage, by researchers in measuring outcomes of treatment methods, policy makers for tracking access to care and quality of care, and health plans for case management, disease management, quality improvement, payments to providers, and underwriting activities [124, 125]. Growth in consumer driven health plans is driving the need for improved risk assessment accuracy, as the employee has more options in selecting benefits plans, and increases variability among the plan populations. Risk adjustment then allows the health plan to determine project outcomes appropriately or make equal payments to promote quality improvements rather than population selection, and ensure comparative price and consumer choice [124].

Healthcare fraud and abuse cost public and private sectors billions of dollars, and in the US these costs are estimated as high as 10% of annual spending or $100 billion per year. Many health systems rely on human experts for manual review. Manual monitoring is often expensive and ineffective. Data mining can reduce costs and identify previously unknown patterns and trends [126, 127]. Increasingly healthcare entities are using data mining tools to identify fraudulent behaviors. Data mining methods including classification tree, neural network, regression have been applied to healthcare . The Utah Bureau of Medicaid Fraud, Australian Health Insurance Commission, and Texas Medicaid Fraud and Abuse Detection, mined data to identify fraud and abuse, saving and recovering millions of dollars. Most fraud and abuse cases are associated with diagnosis and services, some studies utilized provider name, id, demographics, claim patient, procedure, charge, bill date, and payment deductible, copayments, insurance, and payment dates to detect fraud [126, 128].

Health plans are increasingly requiring prior authorizations for services, and 90% require fax or phone. Most medical policies and technology assessments are not standardized and often out of date. These can be standardized for systematic communication, and centralized for more timely updates. Current turnaround times are 3-4 days, which is long after the patient has sought services. Web-services offer the ability to check eligibility, care guidelines, and routine approvals. There may occur through a short series of questions utilizing decision trees to determine an answer in real-time. Medical policies and guidelines are also updated dynamically, and can be linked to electronic health records to improve information transparency among stakeholders [129].

9.4 Model

Following the approaches of Zhang and Demirkan, a BI 2.0 data mining services architecture is developed and shown in Figure 31. The data layer contains the raw data from local or remote sources, along with the meta-data. The data layer provides data transparency to the underlying source, and is cached to improve performance being accessed most frequently. The information layer has domain specific components and connectors, and aggregates the raw data. Domain specific tools are utilized such as simulation, geospatial or optimization models. The knowledge layer applies data mining, knowledge discovery and simulation for decision making. The knowledge layer is responsible for generating domain specific knowledge, for use in decision making processes. The presentation layer is the web-based interface with user friendly interfaces. The presentation layer manages lower layers, and provides data, information, and services to end-users via the web. The horizontal layers are able to be vertically integrated, which allows re-use of services and resources. This provides a flexible firm architecture able to rapidly adapt to changing business conditions. [112, 130].

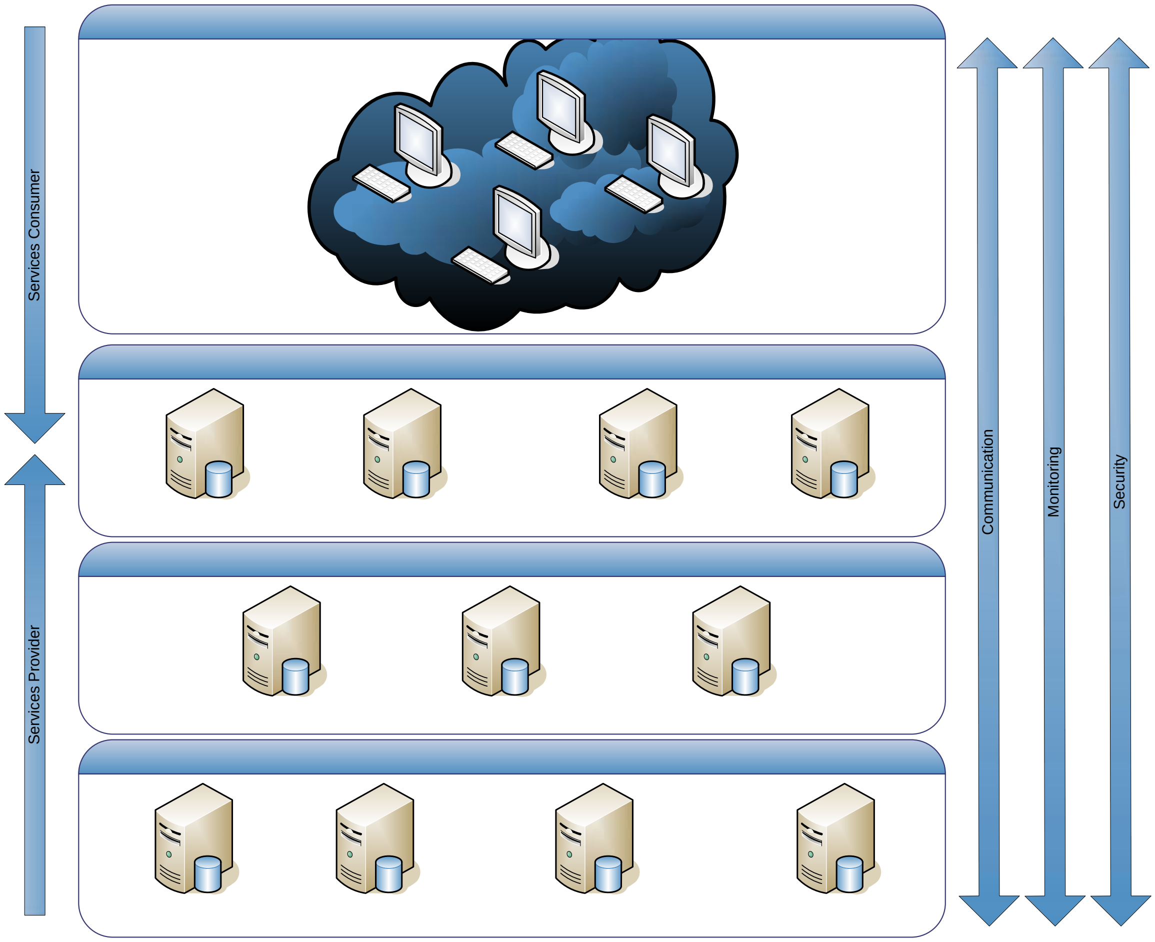


Figure 31: Healthcare Data Mining Services Architecture

Consider the following example of a healthcare services review request and response delivered real-time via SaaS on a per transaction cost basis. A 278 HIPAA EDI transaction [131] is sent in X12 format via a standard service entered via a web browser through the application layer. For illustration purposes, a single use service with input / output within a standard web browser is shown. The services may be performed and utilized by various individuals such as a patient, provider, and payer, or invoked programmatically for high volume and report services. The 278 follows a per patient event relationship which is fitting for a SaaS model, and where utilization management, payer and provider entities are not required to maintain local system software and

Quality Indicato

hardware, instead all layers are able to be managed remotely and accessed through a web-based application layer.

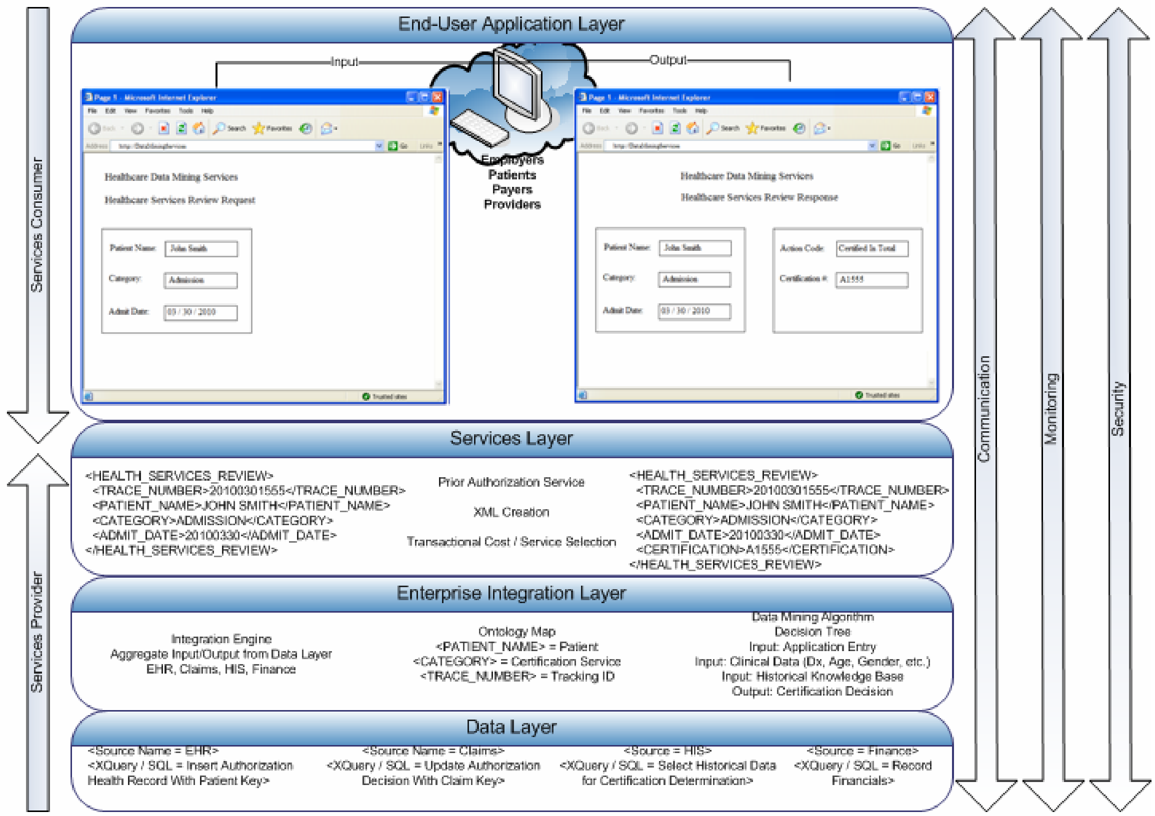


Figure 32: Healthcare Data Mining Services Example

The EDI transaction which is sent in X12 format is then converted to a standard xml message for usage within the integration and data layer. The specified prior authorization service is selected, along with corresponding transactional cost, an service selection credentials. The XML and service information is utilized within the integration layer. The integration layer auto-maps the ontology for standard HIPAA and HL7 messages, or allows users to custom map elements through the application layer for single use ability. Several services occur within the integration layer; the first selects and aggregates historical data, second rule information is gathered for feeds into the data mining algorithm and decision tree. The decision tree data mining algorithm is utilized to determine the certification outcome from the historical knowledge based and input data. Within the data layer certification information is inserted into the patient record via an XQuery command, third claim information is updated to certify services for payment, and fourth financial liability is recorded within a financial system. This information is utilized within layers to present a final authorization through the application layer in real-time. Future services can be utilized by other stakeholders relative to this transaction, for example patients can view healthcare information on medical decisions.

9.5 Future Directions Conclusion

Healthcare entities are increasingly investing in information services, however most on premise solutions require staff experts to implement, maintain, and extract information for end-users. This absorbs resources which may be otherwise used for patient care and quality. BI 2.0 healthcare services can be implemented utilizing an enterprise integration framework to allow stakeholders access to information and capabilities on demand, without dedicated IT staff. This also provides a unified data and information set across all services, allowing any stakeholder to transparently utilize services on a per transaction basis or subscription basis on demand. The service set can be extended and categorized as patient services, provider services, payer services, and employer services. Future directions include establishing standards around healthcare data mining services and development of value added services and applications to support healthcare quality and cost improvements.

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APPENDIX

Measurement Tool

The following survey is part of our ongoing effort to evaluate and improve the effectiveness of Business Intelligence Systems (BIS) across the organization. All responses will be aggregated and anonymous.

<u>Individual:</u>

Position/Level
- Executive
- Vice President
- Director
- Manager
- Supervisor
- Professional

Company tenure
- < 2 years
- 2-3 years
- 4-5 years
- 6-7 years
- 7-8 years
- 8-9 years
- > 10 years

Functional Area
- Sales
- Marketing

Facilities
Finance
Human Resources
Information Technology
Clinical
Business Operations
Other

Age*
<25
25 - 34
35 - 44
45 - 54
55 - 64
> 64

Gender*
Male
Female

#	Please select your level of agreement for each of the following statements below in terms of the Business Intelligence System (BIS), with 1 being least favorable agreement, and 7 the most favorable agreement.	Strongly Disagree 1	Disagree 2	Somewhat Disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly Agree 7	Supporting Works
1	I have knowledge of technical systems								Vandenbosch and Higgens (1995); Pijpers (2001)
2*	I am technically competent								Vandenbosch and Higgens (1995); Pijpers (2001)
3*	I have computer use knowledge								Vandenbosch and Higgens (1995); Pijpers (2001)
4	I learn new applications quickly								Vandenbosch and Higgens (1995); Pijpers (2001)
5	The BIS is easy to use								Vandenbosch and Higgens (1995)
6*	The BIS can be adapted to meet a variety of uses								Wixom (2005)
7**	The BIS is versatile in addressing needs as								Wixom (2005)

	they arise								
8	The BIS system is useful for analyzing company performance								Vandenbosch and Higgens (1995)
9	The BIS performs reliably								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
10*	The operation of the BIS is dependable								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
11*	The BIS allows information to be readily accessible to me								Baily (1983); Wixom (2005)
12	Using a single software vendor for all The BIS components is effective								Howson (2008)
13**	The BIS effectively combines information across the organization								Wixom (2005)
14	The BIS effectively combines information across the organization								Wixom (2005)
15	The BIS provides me with a complete set of information								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
16*	The BIS provides me with all the information I need								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
17	The information provided by the BIS is accurate								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
18	The BIS makes information easy to access								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
19*	The BIS produces the most current information								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
20**	The BIS information is up to date								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
21*	The information provided by the BIS is well formatted								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)

22	The information provided by the BIS is clearly presented on the screen								Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
23	The BIS supports organizational communication								Kim (1993); Spector (2006); Chang (2007)
24	The BIS supports knowledge sharing across teams								Kim (1993); Spector (2006); Chang (2007)
25	The BIS improves my insights								Vandenbosch (1995)
26	The BIS improves department creativity								Vandenbosch (1995)
27	The BIS is useful for testing business assumptions								Vandenbosch (1995)
28	The BIS improves my understanding of the business								Vandenbosch (1995)
29	The BIS is useful for staying close to the business								Vandenbosch (1995)
30	The BIS increases department business focus								Vandenbosch (1995)
31	The BIS allows the organization to keep up with the competition								Vandenbosch (1995)
32	The BIS allows the organization to surpass the competition								Vandenbosch (1995)
33*	The BIS improves the ability to retain customers								Bernhardt (2000); Chang (2007); Chi (2009)
34*	The BIS improves the ability to attract new customers								Bernhardt (2000); Chang (2007); Chi (2009)
35*	The BIS contributes to improved stakeholder satisfaction								Bernhardt (2000); Chang (2007); Chi (2009)
36**	The BIS supports increases in productivity								Lopez (2004)
37**	The BIS contributes to increases in sales								Lopez (2004)
38	The BIS IS employees give prompt service								Delone and Mclean (2002)
39	The BIS IS employees have the knowledge to do their job well								Delone and Mclean (2002)
40	The BIS IS employees have the users' best interests at heart								Delone and Mclean (2002)
41	The BIS software is up to date								Delone and Mclean (2002)
42	The BIS IS support is dependable								Delone and Mclean (2002)
43	The organization is committed to learning								Chan (2003), Chang (2007)

44	The organization shares a common vision							Kim (1993); Spector (2006); Chang (2007)
45	Innovation is an important aspect of the corporate culture							Chan (2003), Chang (2007)
46	The BIS contributes to knowledge sharing across the organization							Kim (1993); Spector (2006); Chang (2007)
47	Historical information is readily accessibly through the BIS							Chan (2003), Chang (2007)
48	The BIS enables team collaboration							Chan (2003), Chang (2007)
49	The BIS supports improved shareholder satisfaction							Bernhardt (2000); Chi (2009)
50	The BIS supports to improved employee satisfaction							Davis and Davis (1990); Janz (2003); Yu (2009); Bernhardt (2000); Chi (2009)
51	The BIS supports to improved customer satisfaction							Bernhardt (2000); Chang (2007); Chi (2009)
52	The BIS supports quality of reviews							Bernhardt (2000); Chang (2007); Chi (2009)

Survey Instrument Key:

*****Item was removed after pre-tests
**Item was updated after pre-tests

User Characteristics
-Individual introduction questions 1-3
-Survey questions 1-4

System Quality
-Survey questions 5-14

Information Quality
-Survey questions 15-22

Learning
-Survey questions 23-30, 43-48

Mental Model Building
-Survey questions 25-27

Mental Model Maintenance
-Survey questions 28-30

Organizational Learning
-Survey questions 23-24, 43-48

Competitive Performance
-Survey questions 31-37

Service Quality
-Survey questions 38-42

Quality Organization
-Survey questions 49-52

Interview Questions

- **Information Quality**
  - What information is most commonly used to make decisions?
  - What is the major source of pain / limitation?
  - What are the sources / systems of information?
  - What information needs to be integrated for reporting?
  - What information can be on it's own?
  - How often does data needed to be updated (real-time, daily)?
  - What system data is needed?
  - How long does data need to be retained? Can it be archived?
  - Are legacy data systems still accessed and needed?
  - From what locations does data need to be accessed?
  - What security should be in place? Who needs access?
  - How large is the data (columns/records)?
  - What are the expected data growth rates?
  - Is there business/technical metadata available?
  - Are business rules available?
  - Who is the owner of the data?
  - Are there multiple potential sources for the same data?
  - What metadata information is needed?
  - What metadata security/access is needed?
  - What is the cause of data inconsistencies? How can we correct?
  - What is the result of data inconsistencies?
  - What other data quality issues exist? Are these documented?
  - What is the measure for clean data? What is the acceptable margin?
  - How do you measure information quality?
- **System Quality**
  - What tools are used to access that data?
  - What reports are currently used? Examples of each? Priority of each?
  - What new reports are needed? Priority?
  - What questions are unable to be answered today?
  - What routine analyses are performed?
  - Who are the reports delivered to? Most frequent?
  - How the reports delivered (method/format)?
  - What are the most common fields used?
  - How many different fields/dimensions are needed?
  - How often are field/dimensions added/updated?
  - What rules are applied to the data?
  - What formatting is applied to the data?
  - Are the reports easy to reconcile?
  - What decisions are made from the reports?
  - Who are the reports delivered to?
  - How are reports distributed?
  - What is the level of detail required? Summary / Detail?

    - What are the common dimensions that are summarized?
    - Will detail level drill-downs be needed?
    - What types of summary/aggregation is needed?
    - Are reports standard or ad-hoc in nature?
    - How should the reports be accessed (web, desktop)?
    - What are the area success metrics? How should these be reported?
    - Describe the ad-hoc request process. What is the typical timeline?
    - Required performance (seconds, minutes, hours)?
    - Required availability of system (M-F, M-S, 8am-8pm, etc.)?
    - Required recoverability?
    - Required audit trail?
    - Required security?
    - Required currency?
    - How do you measure system quality?
- **Service Quality**
    - What is the technical knowledge of the support representatives?
    - How long does it usually take to resolve incidents?
    - Do the support representatives handle themselves professionally?
    - How are status updates sent/received?
    - Do the solutions implemented provide an effective result?
- **User Characteristics**
    - Who are the users (running reports, viewing reports)?
    - How many users (running reports, viewing reports)?
    - What is the level of technical literacy?
    - What is the position of the users?
    - Training needed?
- **Use**
    - How often will they access the system?
    - How often are reports needed (daily, weekly, monthly, etc.)?
    - How often would databases be accessed?
- **Learning**
    - How does the organization share a common vision?
    - What is the organizational commitment to learning?
    - How open minded is the organization?
    - Does everyone in the organization participate in the learning processes?
- **Mental-model building**
    - Requirements for testing new business models?
    - How often would system be used for developing new products?
    - Requirements for generating new information/trends?
    - Requirements for data mining or uncovering new relationships?
    - What opportunities exist to dramatically impact your business based on improved access to information?
    - How do you tell when your organization might be headed for trouble?
- **Mental-model maintenance**
    - Capability to track ongoing metrics?
    - Requirements for performance management?

- What should happen when metrics do not meet targets?
    - How can users stay close to operational results?
    - How often do you measure success? How often would you like to measure?
    - How do you spot exceptions in your business?
    - How would you like to find exceptions?
- **Quality Organization**
    - Describe the mission statement?
    - What does quality mean in the organization?
    - How do you measure quality?
    - How do you measure stakeholder satisfaction?
    - How do you achieve quality?
- **Competitive Performance**
    - Describe the vision statement?
    - What would you pay for receiving cleaner data?
    - Getting reports earlier?
    - Access to information as needed?
    - What competitive advantages would be gained?
    - Would revenue or profit increases be expected?

Construct Development & Definitions

Item	Dimensions	Definition	Supporting Works
Individual Learning	**Self-Efficacy**	Belief in one's technical ability	Vandenbosch and Higgens (1995); Pijpers (2001)
	Mental Model Maintenance	New information is incorporated into existing shared mental models	Vandenbosch and Higgens (1995); Fulmer (1998); Chang (2007)
	Mental Model Maintenance	Shared mental models are modified based on new information	Vandenbosch and Higgens (1995); Fulmer (1998); Chang (2007)
Systems Quality	**Response Time**	Elapsed time for completion of user request	Baily (1983);Vandenbosch and Higgens (1995)
	Ease of Use	Ease of system interaction	Vandenbosch and Higgens (1995)
	Reliability	Consistency, uptime	Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
	Accessibility	Ability to utilize the system capabilities from various locations	Baily (1983); Wixom (2005)
	Integration	Ability to integrate with other systems	Wixom (2005)
	Flexibility	Ability to accommodate changes and new requirements	Wixom (2005)
matio n Quali ty	**Analysis Capability**	Ability to analyze information	Vandenbosch and Higgens (1995)

	Completeness/Specificity	Comprehensiveness of the output	Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
	Accuracy	Sufficiently correct for intended use	Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
	Currency/Timeliness	Availability at time of need	Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
	Format/Interpretability	Intuitive environment	Baily (1983); Vandenbosch and Higgens (1995); Wixom (2005)
	Relevance	Applicability to decision task	Vandenbosch and Higgens (1995)
Service Quality	**Assurance**	Knowledgeable IS employees	Delone and Mclean (2002)
	Empathy	IS employees support end user interests	Delone and Mclean (2002)
	Responsiveness	IS employees prompt service	Delone and Mclean (2002)
	Reliability	IS employees dependability	Delone and Mclean (2002)
Organizational Learning	**Organizational Mental Model Maintenance**	New information is incorporated into existing shared mental models	Vandenbosch and Higgens (1995); Fulmer (1998); Chang (2007)
	Organizational Mental Model Maintenance	Shared mental models are modified based on new information	Vandenbosch and Higgens (1995); Fulmer (1998); Chang (2007)
	Commitment to learning	Organizational learning is viewed as a core value	Chan (2003), Chang (2007)
	Shared Visions	Top management shares the organizational vision with employees.	Kim (1993); Spector (2006); Chang (2007)
	Open-mindedness	The organization goes beyond regular thinking	Chan (2003); Spector (2006); Chang (2007)
Quality Organization	**Employee Satisfaction**	Ability to meet employee expectations	Davis and Davis (1990); Janz (2003); Yu (2009); Bernhardt (2000); Chi (2009)
	Customer Satisfaction	Ability to meet customer expectations	Bernhardt (2000); Chang (2007); Chi (2009)
	Shareholder Satisfaction	Ability to meet shareholder expectations	Bernhardt (2000); Chi (2009)
Competitive Performance	**Profit**	Sales less costs	Lopez (2004)
	Revenue	Sales	Lopez (2004)
	Competitive Perception	Ability to retain customers, ability to capture additional customers	Vandenbosch and Higgens (1995)

Definition	**Authors**

"BI is not a single product, nor a single technology, nor a single methodology. BI combines products, technologies, and methods to organize key information that management needs to improve profit and performance. Think of BI as business information and business analyses within the context of key business processes that lead to decision and actions that result in improved business performance."	Williams and Williams
"BI is a set of technologies and processes that allow people at all levels of an organization to access and analyze data."	Howsen
"BI is fundamentally about providing business people with the information and tools they need to make both operational and strategic business decision." "BI system is the whole thing: source system extracts, ETL, dimensional database in both relational and OLAP, BI applications and an ad-hoc query tool, management tools, documentation, training, security, etc."	Mundy, Thornthwaite, and Kimball.
"BI is the conscious, methodical transformation of data from any and all data sources into new forms to provide information that is business-driven and results-oriented. It will often encompass a mixture of tools, databases, and vendors in order to deliver an infrastructure that not only will deliver the initial solution, but also will incorporate the ability to change with the business and current marketplace."	Ranjan
"Business Intelligence (BI) is a business management term that refers to applications and technologies used to gather, provide access to, and analyze data and information about their company operations."	Shah
BI is not a single product, application, program, user, area, or system, rather an all encompassing architecture of integrated systems and methods that provide all stakeholders with information for decision making and learning.	Woodside
BIS refers to applications and technologies used to gather, capture, access, consolidate, and analyze information to improve decision making. These systems capture important metrics on business operations, as well as providing a mechanism for improved decision making. At the various levels these information items may include documents, calendars, wikis, links, reports, dashboards, scorecards, search, databases, lists, user knowledge, and much more. For example, these technologies can help coordinate projects, calendars, schedules, discuss ideas, review documents, share information, keep in touch with others, utilize Key Performance Indicators (KPI) to gauge operational status, and generate reporting information on-demand. The BIS process is one that allows large amounts of disparate data to come together into a single repository and turn that data into meaningful information for decision support processes. BIS can include various forms of analysis, data mining, scorecards, dashboards, metrics, reporting, portals, data warehouse, OLAP, decision support, knowledge management, etc. This information is available to all levels of the organization and associated stakeholders, on-demand, and in an easy-to-use fashion.	Woodside

"The quality organization has implemented a set of interdependent behaviors aimed at satisfying its stakeholders."	Rodrigues
"A quality organization is one that approaches management based on value adding principles, like the principles of cooperation, teamwork, a focus on customers and employees, a focus on wellness in the workplace, and a focus on continuous learning and continuous improvement."	Perry
A quality organization is one which balances and maximizes the relationships between employee, customer, and shareholder expectations. A quality organization can be improved through organizational learning vis a vis BIS capabilities.	Woodside

Analysis Methods