SOMETHING OLD, SOMETHING NEW: A CASE STUDY OF THE APPLICATION OF THE SYSTEMS DEVELOPMENT LIFE CYCLE (SDLC) IN 21ST CENTURY HEALTH CARE

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ABSTRACT

The systems development life cycle, while undergoing numerous changes to its name and related components over the years, has remained a steadfast and reliable approach to software development. This paper discusses the application of the SDLC in a 21st century health care environment. Specifically, it was utilized for the procurement of a software package designed particularly for the Home Health component of a regional hospital care facility. By following the stages of the SDLC, an effective software product was identified, selected, and implemented in a real-world environment. Lessons learned from the project, and implications for practice, research, and pedagogy, are offered. Insights from this study can be applied in a variety of classroom environments and curricula including, but not limited to, the systems analysis and design course required of all MIS/CIS degree programs as well as the core IS class mandatory for all business school majors.

1.0 INTRODUCTION

The systems development life cycle, in its variant forms, remains one of the oldest and yet still widely used methods of software development and acquisition methods in the information technology (IT) arena today. While it has evolved over the years in response to ever-changing scenarios and paradigm shifts pertaining to the building or acquiring of software, its central tenants are as applicable today as they ever were. Life-cycle stages have gone through iterations of different names and number of steps, but at the core the SDLC is resilient in its tried-and-true deployment in business, industry, and government.

This paper describes the use of the SDLC in a real-world heath care setting involving a principle component of a regional hospital care facility. First, a review of the SDLC is warranted, followed by a description of the case study environment. Next, the application of the methodology is described in detail. Following, inferences and observations from the project are presented, along with lessons learned. Finally, the paper concludes with implications for the three areas of research, practice, and pedagogy, as well as suggestions for future research.

2.0 BACKGROUND

The SDLC has been a part of the IT community since the inception of the modern digital computer. A course in Systems Analysis and Design is requisite of any accredited program in Management Information Systems (MIS) and Computer Science (although the latter takes a different track in its approach). While such classes offer an overview of many different means of developing or acquiring software (e.g., prototyping, extreme programming, rapid application development (RAD), joint application development (JAD), etc.), at their heart such programs still devote a considerable amount of time to the SDLC, as they should. As this paper will show, following the steps and stages of the methodology is still important today to ensure the successful deployment of software. While the SDLC, and systems analysis and design in general, has evolved over the years and decades with changes to its name in order to remain current (e.g., software engineering, agile development, modeling, etc.), at its heart it remains a robust methodology for developing software and systems.

Early treatises of the SDLC promoted the rigorous delineation of necessary steps to follow for any kind of software procurement. The Waterfall Model (Boehm, 1976) is one of the most well-known forms. In this classic representation, the methodology involves seven sequential steps: 1) System Requirements and Validation; 2) Software Requirements and Validation; 3) Preliminary Design and Validation; 4) Detailed Design and Validation; 5) Code, Debug, Deployment, and Test; 6) Test, Preoperations, Validation Test; and 7) Operations, Maintenance, Revalidation. In the original description of the Boehm-Waterfall software engineering methodology, there is an interactive backstep between each stage (Figure 1). Thus the Boehm-Waterfall is a combination of a sequential methodology with an interactive backstep (Burback, 2004).

Other early works were patterned after the Waterfall Model, with varying numbers of steps and not markedly different names for each stage. For example, Gore and Stubbe (1983) advocated a four-step approach consisting of the study phase, the design phase, the development phase, and the operation phase (p. 25). Martin and McClure (1988) described it as a multistep process consisting of five basic sequential phases: analysis, design, code, test, and maintain (p. 18). Another widely used text (Whitten, Bentley, and Ho, 1986) during the 1980s advocated an eight-step method. Beginning with 1) Survey the Situation, it was followed by 2) Study Current System; 3) Determine User Requirements; 4) Evaluate Alternative Solutions; 5) Design New System; 6) Select New Computer Equipment and Software; 7) Construct New System; and 8) Deliver New System.

Even one of the most current and popular systems analysis and design textbooks (Kendall and Kendall, 2011) does not depart from tradition, emphasizing that the SDLC is still primarily comprised of seven phases. Although not immune to criticism, Hoffer, George, and Valacich (2011) believe that the view of systems analysis and design taking place in a cycle continues to be pervasive and true (p. 24). Thus, while the SDLC has evolved over the years under the guise of different combinations of naming conventions and numbers of steps or stages, it remains true to form as a well-tested methodology for software development and acquisition. We now turn our attention to how it was utilized in a present-day health care setting.

2.1 Case study setting

The present investigation regards the selection of a software package by a medium-size regional hospital for use in the Home Health segment of their organization. The hospital (to be referred to in this monograph by a fictitious name, General Hospital) is located in the central portion of a southern state in the USA, within 30 minutes of the state capital. Its constituents reside in the largest SMSA (standard metropolitan statistical area) in the state and consist of both rural, suburban, and city residents. The 149-bed facility is a state-of-the-art institution, as 91% of their 23 quality measures are better than the national average ("Where to Find Care", 2010). Services offered include Emergency Department, Hospice, Intensive Care Unit (ICU), Obstetrics, Open Heart Surgery, and Pediatrics. Additional components of General Hospital consist of an Imaging Center, a Rehabilitation Hospital, Four Primary Care Clinics, a Health and Fitness Center (one of the largest in the nation with more than 70,000 square feet and 7,000 members), a Wound Healing Center, regional Therapy Centers, and HomeCare (the focal point of this study).

2.2 Home health and study overview

Home Health, or Home Care, is (as the name would imply) the portion of health care that is carried out at the patient's home or residence. It is a participatory arrangement that eliminates the need for constant trips to the hospital for routine procedures. For example, patients take their own blood pressure (or heart rate, glucose level, etc.) using a device hooked up near their bed at home. The results are transmitted to the hospital (or in this case, the Home Health facility near General Hospital) electronically and are immediately processed, inspected, and monitored by attending staff.

The author was approached by his neighbor, a retired Accounting faculty member who is a volunteer at General Hospital. He had been asked by hospital administration to investigate the acquisition, and eventual purchase, of software to perform the Home Health care portion of their business. The volunteer, who holds a doctorate in Accounting, knew that this project was outside his domain of expertise and as such enlisted the help of the author, an MIS professor who has taught the SAD course more than two dozen times in his career. After an initial meeting to offer help and familiarize ourselves with the task at hand, we met with staff (i.e., both management and the end-users) at the Home Health facility to begin our research.

3.0 THE SDLC IN ACTION

3.1 Analysis

3.1.1 Problem definition

As is taught in colleges and universities offering MIS/CIS degrees, the first step in the Systems Development Life Cycle is the Problem Definition component of the Analysis phase. One would be hard-pressed to offer a solution to a problem that was not fully defined. As such, in our case the Home Health portion of General Hospital had been reorganized as a separate, subsidiary unit located near the main hospital in its own standalone facility. Furthermore, the software they were using was at least seven years old and could simply not keep up with all the changes in billing practices and Medicare requirements and payments. The current system was not scalable to the growing needs and transformation within the environment. Thus, in addition to specific

desirable criteria of the chosen software (described in the following section), our explicit purpose in helping General was twofold: 1) to modernize their operations with 21st century technology; and 2) to provide the best patient care available to their clients in the Home Health arena.

3.1.2 Requirements analysis

In the Requirements Analysis portion of the Analysis stage, great care is taken to ensure that the proposed system meets the objectives put forth by management. To that end, the author and his colleague met with the various stakeholders (i.e., the Director of the Home Care facility and potential end-users) to map out the requirements needed from the new system. Copious notes were taken at these meetings, and a conscientious effort to synthesize our recollections was done. Afterwards, the requirements were collated into a spreadsheet for ease of inspection (Exhibit 1). In the first column are the requirements set forth by management and the end users; for illustration purposes, many of them are described here:

MEDITECH Compatible: this was the first, and one of the most important requirements, at least from a technological viewpoint. MEDITECH (Medical Information Technology, Inc.) has been a leading software vendor in the health care informatics industry for 40 years ("About Meditech", 2010). It is the flagship product used at General Hospital and is described as the number one health care vendor in the United States with approximately 25% market share ("International News", 2006). Because of its strategic importance to General, and its overall large footprint in the entire infrastructure and day-to-day operations, it was imperative (and non-negotiable) that the new software would be Meditech-compatible.

Point of Care Documentation: Electronic medical record (EMR) point-of-care (POC) documentation in patients' rooms is a recent shift in technology use in hospitals (Duffy, Kharasch, Morris, and Du, 2010). POC documentation reduces inefficiencies, decreases the probability of errors, promotes information transfer, and encourages the caregiver to be at the bedside or, in the case of home care, on the receiving end of the transmission.

OASIS Analyzer: OASIS is a system developed by the Centers for Medicare & Medicaid Services (CMS), formerly an agency of the U.S. Department of Health and Human Services, as part of the required home care assessment for reimbursing health care providers. OASIS combines 20 data elements to measure case-mix across 3 domains–clinical severity, functional status and utilization factors ("Medical Dictionary", 2010). This module allows staff to work more intelligently, allowing them to easily analyze outcomes data in an effort to move toward improved clinical and financial results ("Butte Home Health", 2009). Given its strategic link to Medicare and Medicaid reimbursement, OASIS Analyzer was another non-negotiable, "must have" feature of the new software.

Physician Portal: the chosen software package must have an entryway for the attending, resident, or primary caregiver physician to interact with the system in a seamless fashion. Such a gateway will facilitate efficient patient care by enabling the physician to have immediate access to critical patient data and history.

Other "Must Haves" of the New Software: special billing and accounts receivable modules tailored to Home Health; real-time reports and built-in digital dashboards to provide business intelligence (e.g., OASIS Analyzer); help minimize scheduling time; and last, but certainly not least, the system must be user friendly.

Desirable, But Not Absolutely Necessary, Features: security (advanced, beyond the normal user identification and password type); trial period available (i.e., could General try it out for a limited time before fully committing to the contract?).

Other Items of Interest During the Analysis Phase: is the proposed solution a Home Health-only product, or is it part of a larger, perhaps enterprise-wide system; are there other modules available (e.g., financial, clinical, hospice; applications to synchronize the system with a PDA (Personal Digital Assistant) or smart phone); is there a web demo available to view online; or, even better, is there the opportunity to participate in a live, hands-on demonstration of the software under real or simulated conditions?

Other: the principle investigators also made note of other observations to help them with their selection of the final candidates to be considered for site visits. To gain insight into the experience, dependability, and professionalism of the vendors, we also kept track of information such as: experience (i.e., number of years in business); number of clients or customers; revenues; and helpful (return e-mails and/or phone calls within a timely manner, or at all).

3.2 Design

As previously noted, for this particular case study of software selection, the researchers did not have to proceed through each step of the SDLC since the software products were ready to be deployed immediately. Thus, the Design stage of the SDLC has already been carried out by the vendors. In a similar vein, the coding, testing, and debugging of program modules had too been performed by each vendor candidate. Thus, after painstakingly analyzing all the wares, features, pros and cons, and costs and benefits associated with each product, we were now ready to make a choice: we would whittle our list of five potential vendors down to the two that we felt met our needs and showed the most interest and promise.

3.3 The choice

The principle investigators arranged another meeting with the primary stakeholders of General Hospital's Home Health division. After all, although we had done the research, they were the ones that would be using the system for the foreseeable future. As such, it only made sense that they be as involved as possible – which is in line with what is put forth in any systems analysis and design textbook: user involvement is a key component to system success. Having pored over all of our research notes, in addition to the various brochures, websites, proposals, communications, and related documents from each of our shortlist of five vendors, together as a group we made our decision. We would invite Vendor B for a site visit and demonstration.

Vendor B was very professional, courteous, prompt, and conscientious during their visit. One thing that greatly supported their case was that their primary business model focused on Home

Health software. It was, and still is, their core competency. In contrast, one other vendor (not on our original short list of five) came and made a very polished presentation, in the words of the Director. However, this company was a multi-billion dollar concern, of which Home Health software was only a small part. Thus the choice was made to go with Vendor B.

Ironically, this seller's product was not Meditech compatible, which was one of the most important criteria for selection. However, through the use of a middleware company that had considerable experience in designing interfaces to be used in a Meditech environment, a suitable arrangement was made and a customized solution was developed and put into use.

3.4 Implementation

The Home Care unit of General Hospital utilized the Parallel Installation method for approximately 60 days before the "go live" date. Clinicians would "double enter" patient records and admissions data into both the old and new systems to ensure that the new database was populated, while at the same time maintaining patient care with the former product until its disposal. The Director of the Home Care facility noted that this process took longer than anticipated but was well worth it in the long run. Once the "go live" date was reached the new system performed flawlessly, or at least with a minimal amount of disruption.

It is again worth noting that the implementation method, Parallel Installation, follows from the SDLC and is what is taught in modern-day SAD courses. Thus, it was satisfying to the researchers that textbook concepts were being utilized in "real world" situations. It also reinforced that teaching the SDLC was in line with current curriculum guidelines and should continue.

3.5 Maintenance/support

Software upgrades (called "code loads" by the vendor) are performed every six weeks. The Director reported that these advancements were not disruptive to everyday operations. Such upgrades are especially important in the health care industry, as changes to Medicare and billing practices are common occurrences. She also noted that all end users, including nurses, physical therapists, physicians, and other staff, were very happy with the new system and, collectively, had no major complaints about it. General Hospital expects to use the software for the foreseeable future, with no plans to have to embark on another project of this magnitude for quite some time.

4.0 DISCUSSION

Many inferences and observations were gleaned by both the researchers and hospital staff during the course of the investigation. First, we all learned that we must "do our homework"; that is, much research and analysis had to be performed to get up to speed on the project. For instance, while the principle investigators both had doctoral degrees in business administration, and one of them (the author) had taught the systems analysis and design course for over ten years at two different institutions, neither of us had any practical experience in the Home Health arena. Thus, we had to familiarize ourselves with the current environment as well as grasp an understanding

of the criteria set forth by the stakeholders (both end-users and management). This was an important lesson learned, because we teach our students (in the SAD class) that they must not only familiarize themselves with the application at hand, but they must also interact with the users. Much research has been conducted in the area of user involvement and its relationship to system success (e.g., Ives and Olson, 1984; Baroudi, Olson, and Ives, 1986; Tait and Vessey, 1988). Therefore it was satisfying, from a pedagogical standpoint, to know that concepts taught in a classroom setting were being utilized in a real-world environment.

It was also very enlightening, from the standpoint of business school professors, to see how the core functional areas of study (e.g., marketing, management, accounting, etc., not to mention MIS) were also highly integral to the project at hand. During our research on the various vendor companies, we were subjected to a myriad of different marketing campaigns and promotional brochures, all of which (for the most part) were touting their wares as the "best" ones on the market. Key, integral components (such as billing, scheduling, business intelligence, patient care, electronic medical records (EMR), etc.) that are critical success factors in almost any business were promoted and we were made keenly aware of their strategic importance. Again, this was very rewarding from the point of view from business school professors: we were very pleased that our graduates and students are learning all of these concepts (and more) as core competencies in the curriculum.

The only negative outcome that occurred during the project pertained to simple customer relationship management (CRM), or how some vendors responded (or not) to our initial requests for information. In fact, we disappointingly even had to add a row (criteria) to our spreadsheet to keep up with, simply, whether the company responded to our requests for information. These requests were in one of two forms: e-mail and telephone calls. To our amazement, some vendors (that were identified during the initial research on companies offering the kind of software we desired) did not even bother to respond to our inquiries. This was incredulous to say the least; after all, we had a quarter of a million dollars "burning a hole in our pockets" (i.e., had been given the go ahead or green light from management) and some of these companies did not even bother to respond.

5.0 IMPLICATIONS FOR PRACTICE, RESEARCH, AND PEDAGOGY

5.1 Implications for practice

This project, and case study, was an application of pedagogy on a real-world systems analysis project. As such, it has implications for practice. First, it showed that concepts learned in a classroom environment (such as the SDLC in the systems analysis and design course) can be effectively applied in a business (or in our case, a health care) environment. It was very pleasurable for us, as business school professors (one is retired), to see instructional topics successfully employed to solve a real-world problem. For practitioners, such as any organization looking to acquire a software package, we hope that we have shown that if one applies due diligence to their research effort that positive outcomes can be achieved. We also expect that real-world personnel would take from our study the realization that tried and true methods, such as the SDLC, are good tools to use for projects of a similar nature, and not just academic

exercises to fulfill curriculum requirements. That would probably be one of the most gratifying implications, from the viewpoint of the researchers.

5,2 Implications for research

This project could be used as the beginning of a longitudinal study into the life cycle of the Home Health software product selected. It is customary to note that maintenance can consume half of the IS budget when it comes to software, especially large-scale systems (Dorfman and Thayer, 1997). It would be interesting to track this project, in real time, to see if that is indeed the case. Furthermore, an often-neglected phase of the SDLC is the stage at the very end: disposal of the system. By following the present study to the end, it would be enlightening (from all three viewpoints of research, practice, and pedagogy) to see what happens at the end of the software's useful life.

5.3 Implications for pedagogy

5.3.1 Insights for the SAD course

After learning so much about real-world software acquisition throughout this consulting (unpaid) project, the author has utilized it in classroom settings. First, the obvious connection with the SAD course was made. To that end, in addition to another semester-long project they work on in a group setting, the students pick an application domain (such as a veterinary clinic, a dentist's office, a movie rental store, etc.) and perform a research effort not unlike the one described in this monograph. Afterwards, a presentation is made to the class whereby 3-5 candidate vendors are shown, along with the associated criteria used, and then one is chosen. Reasons are given for the selection and additional questions are asked, if necessary. This exercise gives the students a real-world look at application software through the lens of the SDLC.

Such an exercise enables students to engage in what Houghton and Ruth (2010) call "deep learning". They note that such an approach is much more appropriate when the learning material presented involves going beyond simple facts and into what lies below the surface (p. 91). Indeed, this particular exercise for the SAD students was not rote memorization of facts at a surface level; if forced them to perform critical thinking and analysis at a much greater depth of understanding. Although the students were not able to complete a "real world" project to the extent of those in the Grant, Malloy, Murphy, Foreman, and Robinson (2010) tome, the experience did allow them to tackle a contemporary project and simulate the solving of it with real-world solutions. This gave them a much greater appreciation for the task of procuring software than just reading about it in textbooks. In a similar vein, Magboo and Magboo (2003) earlier touted the benefits of enhancing education through the assignment of real-world projects in a study conducted in the Philippines. Thus, the benefits of having today's young scholars engage in hands-on research in applied settings helps not only further a domestic agenda, but the international community as well.

5.3.2 Insights for IS courses, SAD and non-SAD

Other insights gained, by the SAD students as well as the junior-level MIS course required of all business majors, have to do with what the author teaches during the requisite chapter on software. To wit, the author presents this topic as "the software dilemma". This description is tantamount to the recognition that when acquiring software, businesses must make one of three choices (in general). The options are "make" versus "buy" versus "outsource" when it comes to acquiring software.

Briefly explained, the "make" option presupposes that the organization has an IT staff that can do their own, custom, programming. An example would be a COBOL shop for a large retailer, bank, or insurance company. The "buy" alternative relates to what was described in this paper, in that General Hospital did not have the resources to devote to developing software for their Home Health segment, and as such enlisted the researchers to assist in that endeavor. The "outsource" choice alludes to several different options available, under this umbrella, on the modern-day IT landscape. The decision to outsource could range from an application service provider (ASP) delivering the solution over the internet (or the "cloud") to complete transfer of the IT operation to a hosting provider or even a server co-location vendor.

Thus, a project like this one could be used in the general, required MIS course to further illustrate problems and potential pitfalls faced by businesses, small and large, when it comes to software acquisition. Instructors could use the features of this case study to focus on whatever portion of it they thought best: project management, budgeting, personnel requirements, marketing, etc. It could even be used in a marketing class to investigate the ways in which vendors, offering similar solutions to standard problems, differentiate themselves through various marketing channels and strategies.

Finally, a case study like this one could even be used in an operations management, or project management, setting. The discovery of issues, such as those raised in this paper, could be fruitful research for both undergraduate and graduate students alike. A team project, along with a group presentation as the finale, would also give students much-needed experience in public speaking and would help prepare them for the boardrooms of tomorrow.

6.0 CONCLUSION

Two business school professors, one an MIS scholar and the other retired from the accounting faculty, were called upon by a local hospital to assist with the procurement of software for the Home Health area. These academics were up to the challenge, and pleasantly assisted the hospital in their quest. While both researchers hold terminal degrees, each learned quite a bit from the application of principles taught in the classroom (e.g., the SDLC) to the complexities surrounding real-world utilization of them. Great insights were gained, in a variety of areas, and have since been shown as relevant to future practitioners (i.e., students) in the business world. It is hoped that others, in both academe and commerce, will benefit from the results and salient observations from this study.

REFERENCES

References, Figures, Exhibits, and the full paper are available upon request from the author.