

Supply Chain Automation and the Effect on Clinician Satisfaction and Patient Care Quality in the Hospital Setting

by

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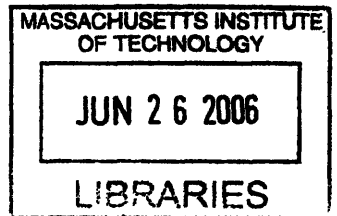
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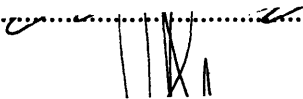
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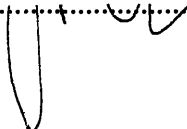


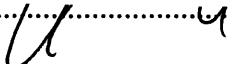
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Abstract

The healthcare industry, more specifically hospitals, has in recent times been experiencing a steady rise in nursing shortages and cost pressures. To offset these problems hospitals have increasingly relied upon supply chain automation and the use of Automated Point of Use systems (APU) to relieve nurses of their supply management responsibilities and allow them to focus more of their time on patient care, and therefore increase nursing job satisfaction and patient care quality. However, previous studies on the effectiveness of APUs have shown mixed results. It has been argued that nursing's attitude towards automation implementations plays a role in determining the success of new technologies adoption. This research, based on interviews conducted at BBC hospital, a well regarded multi-specialty academically affiliated institution, and with the help of its supply chain partner Primera, shows that nursing's perceived success of BBC's APU implementation depends on four factors – the ability of the new technology to show timesaving, the availability of supplies when needed, the accessibility of supplies when needed, and the perceived quality of the products supplied. In sum, automation implementations must use workflow process changes to add tangible values that nursing perceives as helping nurses to perform their jobs better and with less stress. As for both the current BBC implementation and any future implementations, this study further recommends methods in achieving these values and therefore increasing nursing acceptance of new technology implementations.

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1 Introduction

The U.S. Census Bureau projected in 2004 (Online 1) that the total US population would increase from the 2000 census of 282,125,000 to 308,936,000 by 2010, and again to 363,584,000 by 2030 (Table 1), an increase of 9.5 % and 28.9% respectively over year 2000. At the same time, the percentage of population over 65 would also increase from 12.4% in 2000 to 13% by 2010 and 19.7% by 2030 (Table 2).

(Thousands)	2000	2010	2030
Population	282,125	308,936	363,584
Increase	-	9.5%	28.9%

Table 1: Projected US Population Growth
(Source: US Census Bureau, International Data Base, Table 094)

AGE	2000	2010	2030
65-84	10.9%	11.0%	17.0%
85+	1.5%	2.0%	2.6%
> 65	12.4%	13.0%	19.7%

Table 2: Projected US Percent of Total Population Over Age 65
(Source: US Census Bureau, International Data Base, Table 094)

This continued strong growth in U.S. population is a problem that the rapidly aging Europeans would love to have (Online 2), but to the U.S. healthcare system, already at 16% of GDP and projected to increase to 20% of GDP by 2015 (Borger et al, 2006), this is a significant problem, not only in terms of cost, but also in the ability to supply the clinician workforce to support the growing and aging population.

"I begged for help," she said. "We had plenty of time to get help, and we got none."
-- "Nursing Shortage: How It May Affect You." January 21, 2006, ABC World News Tonight

As healthcare costs rose steadily from 1965 through 2004 to 16% of GDP (Figure 1), the industry pursued various strategies to limit its growth. Some strategies, such as the Health Maintenance Organizations (HMOs), proved financially successful, but ultimately politically unsuccessful (Figure 1, Figure 2, 1993 – 2002). Along the way, however, as healthcare entities struggle to maintain financial viability as payers continue to decrease reimbursements for services (Encinosa et al, 2005), and as the advancement of medical care keeps people alive longer, but sicker, clinicians are increasingly facing higher patient-to-nurse ratios and are reporting high levels of job dissatisfaction and burnout (Aiken et al, 2002), which contribute to nursing shortage. In a cross-national study involving more than 43,000 nurses, Aikens et al (2001) reported that job dissatisfaction and burnout for US nurses are the highest amongst five countries surveyed and that one-third of nurses under age 30 is considering leaving the profession within one year.

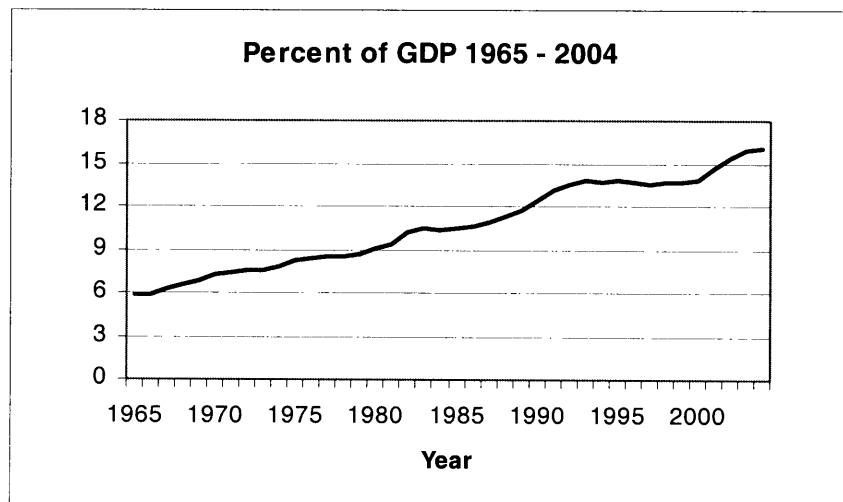


Figure 1: National Health Expenditures as Percent of GDP 1965-2004 (Source: CMS, <http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhegdp04.zip>)

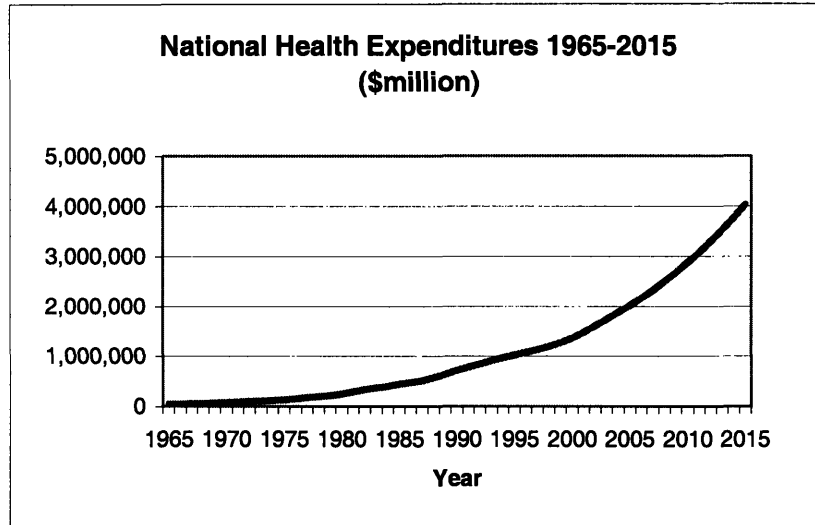


Figure 2: National Health Expenditures 1965-2015 (\$million) (Source: CMS, <http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhegdp04.zip>)

Given that most experts agree that there is a serious shortage of nurses in the US and this trend would not change any time soon (Janiszewski, 2003; Figure 3), many in the industry are looking toward technology as a way to both improve productivity and nursing job satisfaction in addition to help recruit younger nurses (Case et al, 2002).

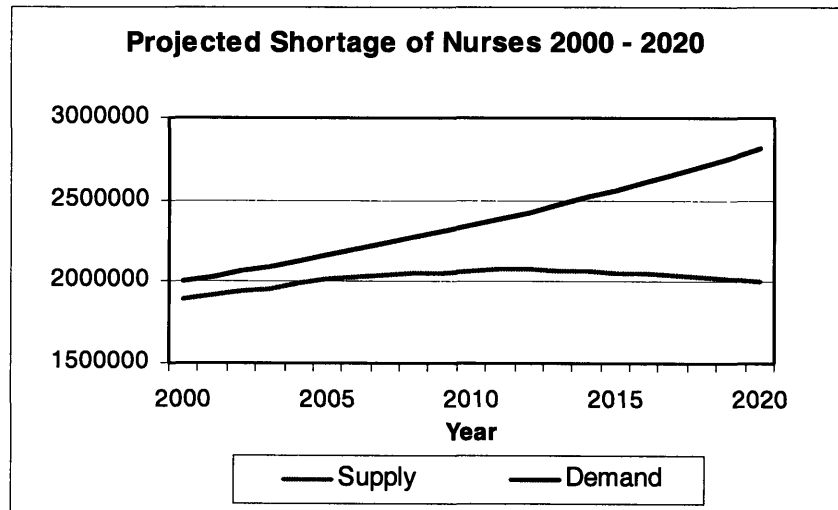


Figure 3: Projected Shortage of Nurses 2000 – 2020 (Source: US Department of Health and Human Services 2002; <ftp://ftp.hrsa.gov/bhpr/nationalcenter/rnproject.pdf>)

It is the focus of this research then, to answer the questions of whether and how technology and automation affect job satisfaction of clinicians, in this case nurses, and whether automation can also help increase the quality of patient care, a major focus of the medical community ever since the landmark Institute of Medicine report published in 2000 that estimated between 44,000 and 98,000 patients die each year as a result of medical errors.

1.1 Thesis Background

This thesis has benefited greatly from the involvement of both Primera, Inc. (Primera), disguised name of a major fortunate 500 medical wholesale supplier, and Back Bay Clinic (BBC), disguised name of a leading multi-specialty academic hospital and clinic in the New England area that is implementing technology based solutions provided by Primera.

Primera entered into a multi-year contractual relationship with BBC in 2005 to implement a strategic partnership style inventory management program (Logistix) featuring automated point of use (APU) supply cabinets in the clinical areas. Prior to the BBC implementation, Primera has implemented more than a dozen similarly constructed Logistix programs across the U.S. (DeScioli, 2005), although not all of these programs are as comprehensive in partnership scope as BBC's.

The implementation of Logistix at BBC started in September of 2005, and this author began the study of the Logistix program and its effects on clinicians in November of 2005. The study involved nearly two dozen face-to-face interviews on multiple occasions (through

March 2006) with nurses, nurse managers, nursing administration, APU system administrators, a Logistix consultant, and various individuals both involved with the implementation and outside third party sources. These interviews were then followed-up with email and phone questions when further details and clarifications were required. In addition, Primera and BBC also provided implementation documentations for further understanding of the actual implementation process and scope.

Although as of March of 2006 the Logistix program is still early in the process of implementation at BBC, initial research discovered evidence that potentially points to delivering timesaving for clinicians and to high satisfaction ratings for the new APU system in specific cases, which will be further discussed in the analysis and conclusion sections of this writing. However, because of the complex nature of the Logistix program and also the hospital environment, this observation is not shared across all departmental implementations. Ultimately, through the analyses of the interview responses, it is the goal of this research to try to shed some light on the observed success factors that contributed to timesavings and high APU satisfaction levels along with potential effect observed, if any, on clinician job satisfaction and patient care quality. It is also the hope of this author that the findings may contribute to future implementation of similar APU based programs at both BBC and other institutions.

1.1.1 BBC Operational Highlights

BBC hospital and clinic highlights (disguised numbers that represent organization size):

- 500 physicians, 850 nurses, 5,000 employees

- 305 bed multi-facility academic teaching hospital with level II trauma center
- 1,000,000 annual outpatient encounters, 20,000 annual inpatient discharges
- 20,000 annual surgical cases

1.2 Thesis Outline

Beginning with Chapter 2 it is the intent of this author to highlight current research and publications on the topics of nursing shortage and suggested reasons for this shortage, and this author will further present a brief survey of technology use in healthcare, including supply chain automation, and the potential effects on clinicians. In Chapter 3, the research methodology used will be detailed, followed by the analyses and discussion of research findings in Chapter 4. Finally, in Chapter 5 the author will conclude by offering some recommendations for Primera, BBC, and anyone else who are facing similar implementations, while leaving some thoughts on potential future direction of healthcare technology automation.

2 Literature Review

In this chapter, this author will try to highlight current researches and publications on the following two topics that are central to this research:

- The shortage of the nurses, the reasons for the shortage, and the effect of shortage, including patient care quality
- A survey of current and potential future use of technology in healthcare and how technology, including the role of supply chain automation, can help nursing and healthcare in general

2.1 Nursing Shortage and the Effect on Patient Care

2.1.1 Nursing Shortage

In July 2002, U.S. Department of Health and Human Services' Bureau of Health Professions (BHP) reported that there were approximately 1.89 million registered nurses (RNs) in the United States in 2000, but this represented a shortage of 6 percent or 110,000 of the total number needed. Furthermore, if this shortage is left unchecked, it may reach 12 percent by 2010 and 29 percent by 2020 (BHP, 2002).

The BHP's numbers are based on data that shows a 26 percent drop in RN graduates in 2000 as compared to 1995 while at the same time fewer candidates are enrolling in educational

programs to pursue nursing careers. In addition, BHPPr also found that there are more than 490,000 licensed RNs not employed in nursing. As a result, the nursing profession is not only in short supply, but also rapidly aging (Figure 4). A comprehensive survey of current literatures on the topic of nursing shortage concurs with BHPPr’s findings (Janiszewski, 2003). In addition, Janiszewski (2003) also pointed to the changing work climate and the poor image of nursing as the reasons for the shortage.

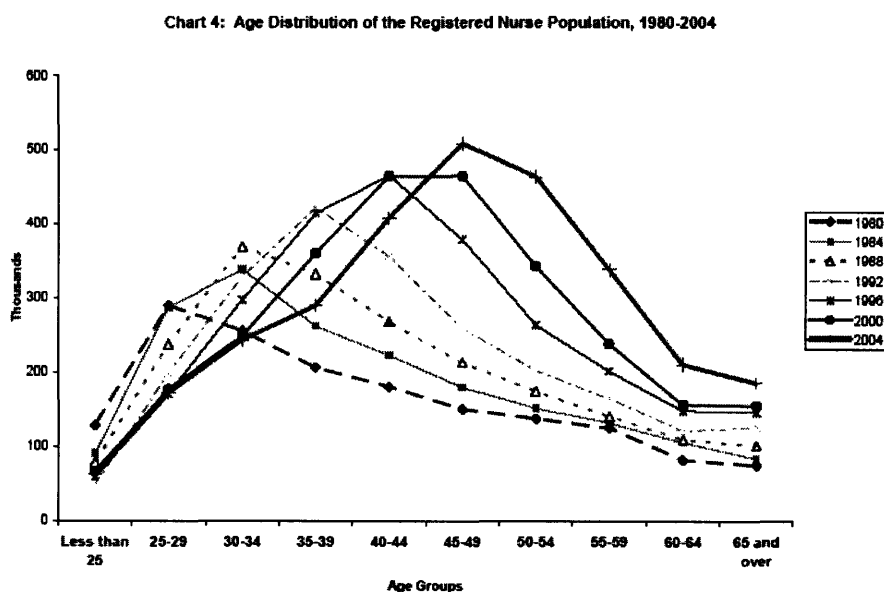


Figure 4: Age Distribution of the Registered Nurse Population, 1980 – 2004 (Source: DHHS; <http://bhpr.hrsa.gov/healthworkforce/reports/rnpopulation/preliminaryfindings.htm>)

In contrast, Buerhaus et al. (2003) found evidence that the current state of nursing shortage may be ending. However, the findings also suggest that the increases in staffing only came from the reentry of older nurses and foreign-born nurses, which is a temporary solution that cannot resolve the long-term problems of the rapidly aging nursing population and the potential lack of supply for foreign nurses in the future (Aiken et al., 2004).

2.1.2 Why a Shortage?

Lee et al. (2003) concluded that the fundamental reason why there is a nursing shortage is because “two population groups (are) moving in the opposite direction – patients and nurses.” With better medical technology, more people are living longer with chronic diseases. However, at the same time, the supply of nurses has not increased to keep pace with the healthcare needs of the growing and aging population.

Lee et al. (2003) further suggested that the reasons why nursing supply has not kept pace are because of fewer people are entering the profession, hospital restructuring in the early nineties overburdened nursing and caused nursing flight (Aiken et al., 2002; Rogers et al., 2004), a shortage of faculties to train new nurses, poor nursing image (Janiszewski, 2003), and problems with further foreign nursing recruitment (Aiken et al., 2004).

2.1.3 Effects of Shortage

With increased shortage, hospitals are experiencing RN vacancy problems. A study commissioned by the American Organization of Nurse Executives in 2001 involving 693 hospitals showed that nationwide hospitals are experiencing, on average, 10.2% vacancy rates for RNs (AONE, 2002). In addition, the average annual turnover rate for RNs is at 21.3 percent, with most hospitals experiencing between 10 and 30 percent.

Given such shortages, hospitals are increasingly looking at overtime as a way to make up for the shortfall in staff. A survey of trends in nurse overtime finds that the amount of nursing

overtime increased 51 percent between 1994 and 2002, with most of the increase occurring after 1997 (Berney et al., 2005). The problem with overtime, however, is that after examining logbooks from 393 hospital staff nurses, Rogers et al. (2004) found that the risk of making an error was higher as the length of the shift increased, and significantly higher when the nurses worked overtime.

In addition to increased overtime, however, nurses nationwide are also experiencing increased patient-to-nurse ratios, so much so that the state of California had to mandate the ratio of at least 1 licensed nurse for every 6 medical and surgical patients beginning in July of 2003 (Aiken et al., 2002). The negative effect of this trend, as reported by Aiken et al. (2002), is that higher patient-to-nurse ratios are associated with higher mortality and failure-to-rescue rates along with higher nurse burnout and job dissatisfaction rates.

With increasing workload and overtime, nurses are increasingly dissatisfied with their work. A cross-national study involving more than 43,000 nurses showed that more than 40 percent of U.S. hospital nurses reported being dissatisfied with their work and emotionally exhausted (Aiken et al., 2001). Furthermore, more than 20 percent of the surveyed nurses intend to leave their jobs within the next year. What is most surprising, however, is that nurses under the age 30 reported a much higher ratio of intent to leave than those over the age of 30.

Given the current state of nursing shortage, the reports of poor medical care quality that show at least 44,000 Americans die each year as result of medical errors (IOM, 2000), and the strong association of higher patient-to-staff ratios and overtime use with lower quality of

care, it should be of particular concern that nurses are stressed out and leaving the profession, which cause the remaining nurses to face even higher level of stress. This is an example of a perpetuating negative feedback cycle that would only lead to worsening levels of both nursing job satisfaction and quality of care (Leiter et al., 1998).

2.2 Technology and Nursing Satisfaction

2.2.1 Technology Use and Nursing Satisfaction

Lee et al. (2003) reported that nurses get satisfaction from providing direct patient care, and yet, one of the reasons why nurses are stressed out is that nurses are tied up in non-nursing work activities. Ball et al. (2002) suggested that healthcare information technology (IT) has the potential to refocus nursing back on direct patient care by transforming the delivery of care through streamlining processes, making procedures more accurate and efficient, and reducing the risk of human error, while providing positive impact on cost-effectiveness, productivity, and patient safety.

According to a study commissioned by the California Healthcare Foundation, many nurses have indeed sought out technologies that help to decrease the likelihood of making a mistake (Case et al., 2002). Some of the technologies that are currently used in healthcare as cited by the report include:

- Nurse Scheduling
- Medication Administration
- Automated Nursing Documentation

- Computerized Patient Record (CPR)/Clinical Data Repository (CDR)
- Clinical Decision Support Functionality
- Mobile Communication and Messaging
- Patient Education
- Computerized Physician Order Entry (CPOE)

In addition to the systems listed above, hospitals are also starting to use real-time electronic dashboards to share information on key performance measurements and quality indicators throughout the organization by connecting user interfaces to hospital information systems (Rosow et al., 2003). Gradually, clinicians, administrators, and policy makers who are committed to evidence-based patient care safety and outcome are realizing the value of using real-time clinical dashboards to track clinical quality indicators, such as, patient falls incidence and hospital-acquired pressure ulcer prevalence (Donaldson et al., 2005).

Although technology based benchmarking approaches to safety, such as dashboards, are needed to help translate lessons so that they are usable and long lasting in healthcare (Amalberti et al., 2005), a culture that is non-punitive, receptive to improvement, and promotes trust is required for the measurements to be accurate and meaningful (Weingart et al., 2003; Firth-Cozens, 2003). Edmondson (1996) found that reported healthcare preventable error rates are a function of at least two influences – the clinician’s ability to catch the error and the clinician’s willingness to report the error. Edmondson (1996, 2004) also found that willingness to report is directly related to how the clinician perceives the organization’s error

handling culture. If the culture is of tolerance and learning, then reporting is done much more frequently. The reverse is true, however, in an environment of non-tolerance.

Overall, studies have concluded that successfully implemented technology-based systems would improve nursing productivity, nursing satisfaction, and enable nurses to spend more time interacting with patients, while at the same time improve a hospital's financial bottom line (Williams et al., 1994; Lee et al., 1992). However, Case et al. (2002) cautions that the adoption of these technology solutions requires extensive changes in workflow and needs the participation of both nurses and physicians. Novek et al. (2000) also found that nurses' attitudes toward the technology being adopted can greatly influence the success of the implementation. Furthermore, Vrabel et al., (1995) found that change management is essential to the successful implementation of technology in the healthcare setting after studying the implementation experiences of two leading academic medical institutions. And finally, Koppel et al. (2005) found that although technology prevents common errors, but it can also introduce new errors due to information system integration failures and human-machine interface flaws.

2.2.2 Supply Chain Automation in Healthcare

Supply chain automation in the healthcare industry can be traced back to the American Hospital Supply Corporation's (AHSC) Analytic Systems Automatic Purchasing (ASAP) computer based remote ordering, tracking, and supply management system. It began operations in 1957 as an internal solution (Short et al., 1992). In 1963, however, ASAP, by then called Tel-American, using proprietary punch-card based IBM Dataphones, was finally

introduced to the client hospitals and ushered in the “prime vendor” phase of vendor-customer relationship in the healthcare industry. AHSC continued to improve its ASAP system through the early 1970s with its focus on high inventory service levels. By the mid 1970s, however, driven by customers’ increasing need to improve internal supply management and cost, AHSC began to offer select customers value-added services, such as, “customer purchase analysis” reports, and for a limited number of large customers, supply-chain consulting services. The results, by the late 1980s, Baxter, who by then had acquired AHSC, was so successful in its ASAP strategy, that out of the approximately 6,900 hospitals nationwide, 5,500 were using the ASAP system.

In the mid to late 1980s, however, Johnson & Johnson and Abbott Laboratories both introduced their own versions of computer based supply chain systems to compete with Baxter. In addition, they no longer allowed Baxter to distribute the supplies they produced. In response, Baxter introduced ASAP Express in 1988, a multi-vendor system that sells eight other vendors’ products in addition to Baxter’s own (Short et al., 1992).

In 1990, Baxter again pushed the envelop in advancing the supplier-customer relationship with the introduction of the Valuelink program, an integrated, strategic partnership based, “logistics system synchronizing the flow of products and information between the customer and Baxter via consolidated purchases and multiple deliveries to point-of-use in the hospital seven days a week” (Short et al., 1992). In other words, this was beginning of Vendor-Managed-Inventory (VMI). The concept of the Valuelink program, however, has its roots in the stockless program that Baxter developed in the mid 1980s. The underlying business

rationale for Valuelink is that the “overall efficiency within the manufacturing-distribution-customer chain increases as the distributor assumes inventory and distribution functions, in exchange for customer purchase commitment” (Short et al., 1992). Byrnes et al. (1991) describes the strategic alliance between Baxter and the hospital as a “partnership of specialists.” In this case, Baxter specializes in materials management and hospitals in patient care. Byrnes, however, cautions that for this strategic partnership to reap the potential benefits, a company must “change the fundamental way it does business.” “Managers must act strategically, developing inter-functional capabilities, and link resources both inside and outside their companies.”

A more recent advancement in hospital supply chain technology has been the use of Automated Point of Use (APU) systems (Figure 5). These devices are placed in the various clinical wards of the hospital and allow authorized users to pull inventory (DeScioli, 2005). The APU usually requires the pull be accompanied by a user action which registers the item(s) taken, such as, pressing the ‘take’ button on the appropriate bin. The benefits of the APU are its ability to keep inventory records while automatically places orders at pre-established frequencies and up to pre-established inventory levels along with its ability to track supply usage against the patient that is used for (charge capture and automatic billing). Another benefit of the APU is its ability to provide inventory visibility across the hospital (DeScioli, 2005). However, this author found that, in certain cases, nursing attitude towards supply sharing is a factor in nurses’ satisfaction rating with the APU system, which will be further discussed in this study. In addition, the author also found evidence that concurs with DeScioli’s assertion that, although APU systems can be effective in controlling inventory,

they can also slow down inventory deployment because of the fact that the users are required to sign in first.



Figure 5: Pyxis Supply Station & Omnicell OmniRX Medication Station

In summary, the evolution of healthcare supply chain management has pushed both suppliers and hospitals into a more integrated relationship that is based on the principle that the expertise of supply chain management lies with the supplier. To this end, technology advancement in healthcare supply chain management has enabled certain suppliers to initiate partnerships with hospitals that are based on the successful integration of information, which is necessary for a mutually beneficial and lasting relationship.

3 Methodology

Both interviews and data analyses were carried in this research. The types of interview methods used were face-to-face, email, and phone conversations, while data analyses were based on both interview responses and available BBC clinical and operational data.

Given the research focus of nursing satisfaction and patient care quality, the primary targets for interviews were nurses and nurse managers. In all, 16 BBC nurse managers and nurses from multiple departments at 2 different facilities (BBC's main facility and one satellite facility) were either face-to-face interviewed (14), or email interviewed (2) on three (not including emails) separate occasions over a two-month period. Other targets of interviews for background information were BBC nursing administration (1), BBC director of materials management (1), BBC Logistix system administrators (5), Primera vice president of sales (1), and Primera Logistix onsite consultant (1). For outside reference the author also interviewed three (3) senior vice presidents and one (1) vice president of a major competitor to Primera. In addition, one (1) CEO of a major academic hospital in Texas that was one of the pilot hospitals of the previous generation Logistix program was also interviewed.

Data analysis was then carried out on the collected data based on both interviews and also hospital statistics shared by nursing administration. Data collected from interviews include nursing tenure information along with job satisfaction rating, and system satisfaction rating. For control, replaced system satisfaction rating was also collected. Responses were ranged on

a scale of 1 to 5, with 5 being most satisfied and 1 being most unsatisfied. The specific questions of the interview are listed in Appendix A. The hospital statistics collected included nursing turnover rates, vacancy rates, Registered Nurse (RN) versus non RN patient care hours, and other clinical quality indicators. The hospital statistics, however, were mostly only available with limited time ranges (from January 2005 to October 2005). With Logistix implementation only started in September 2005 at selected clinical departments, the impact of Logistix cannot yet be measured through hospital statistics. However, the data provides a useful early snapshot of the organizational environment at BBC.

4 Analysis

There are 5 subsections in this chapter of the research, with the initial subsections intend on providing analyses of the background environment of the Logistix program, while the subsequent subsections will primarily focus on the analyses of responses from nurses, but will supplement with responses from others where necessary to provide a more complete analysis.

4.1 BBC Supply Chain Prior to Logistix

BBC had a fairly traditional material management function prior to the implementation of Logistix (Figure 6). In the case of BBC, however, Central Supply was the main operating unit that kept the clinical units supplied by daily checking of unit inventory levels and stocking the units to inventory par levels (stock up to level). Both hospital senior management and Materials Management were generally satisfied with the performance of Central Supply prior to implementation of the Logistix program, so much so that Materials Management was initially against the move to Logistix because it believed the move would degrade the performance level.

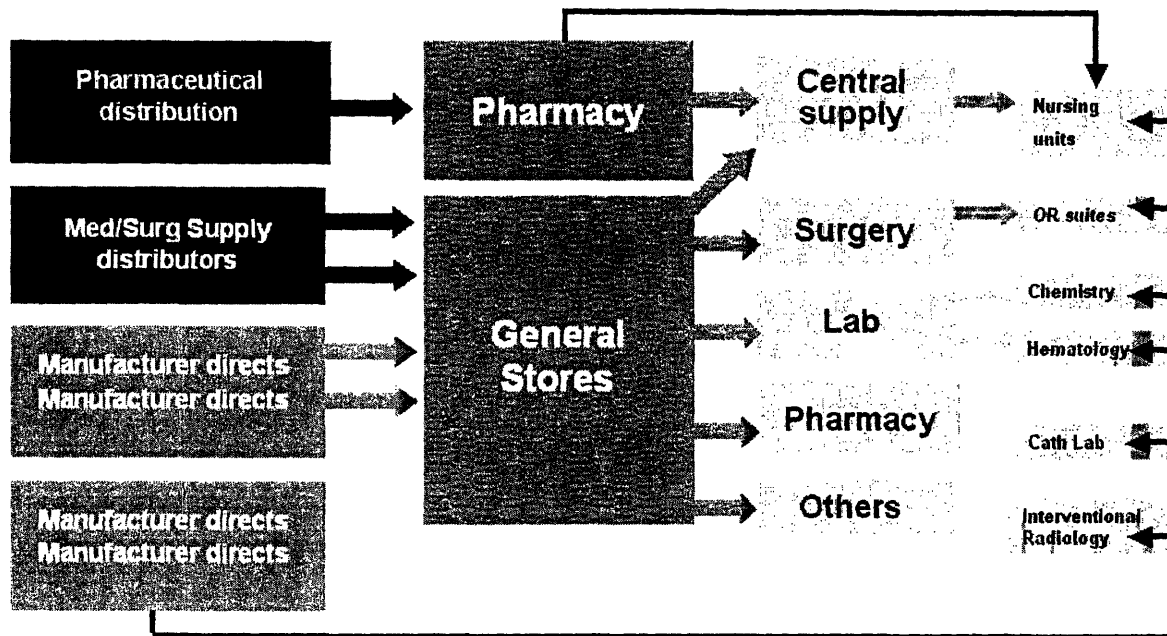


Figure 6: Traditional Supply Chain Example (Source: modified from Primera documents)

In addition to Central Supply, nursing units were also responsible for ordering and receiving specialty products that are specific to the departments' needs. Nurses ordering extra supplies and hoarding (reusable supplies), such as those reported by Oliveira (2005) were common. Like many hospitals, BBC was also very short on storage space. Inventories received and piled up on the clinic floor space were a common sight.

4.2 Primera - BBC Logistix Agreement

4.2.1 Business Environment

Although this author did not ask either Primera or BBC the rational behind their agreement, it appears that the intentions are generally financial in nature.

According to several senior vice presidents of a major competitor of Primera, the wholesale medical supply business is a very low margin business and the margins are getting thinner as the wholesalers are being squeezed by both the manufacturers (who are often time large oligopolies) and the hospitals (who are banding together to negotiate better termed contracts). As the margins get thinner, the wholesalers are all moving into higher margin value-added businesses, such as, logistics consulting and procedure based kitting. In addition, by becoming a prime vendor and locking the client hospital into a multi-year VMI agreement, such as Logistix, even a low margin business can generate sizable profits through volume.

From the hospital side, however, the operating environment of recent years has also gotten tougher. According to the CEO of a major academic hospital in Texas, as competition increases and payers continue to decrease payments for services, strategic partnerships are becoming more important as hospitals are trying to survive financially. In addition, supply chain management traditionally has not been a core competency of hospitals. Optimistically, however, he mentioned that there are “plenty of opportunities” in the hospital supply chain to add to the bottom line.

4.2.2 Prior Relationship and Agreement Scope

Prior to choosing Primera as the supply chain partner BBC had an existing relationship with Primera as a customer of its medication APU system. Overall, BBC (and the nurses) has good feelings toward the medication APU system, and perhaps this was also a contributing factor that led to the expanded partnership agreement with Primera.

Primera's Logistix program with BBC has four main components and it is designed to replace the traditional hospital supply chain with a VMI process (Figure 7):

- **Consultation:** a 15-months process with the goal of identifying opportunities for standardizing supplies and reducing costs
- **Supply Automation:** automated supply distribution and reordering through the use of APU stations that allow ordering based on need, reduce wastes, and provide better control of supplies
- **Pharmacy Distribution:** direct medication distribution from Primera and reordering through the use of the medication APU
- **Medical Products & Services:** tote specific product picking and procedure based kitting (PBK) at supplier warehouses based on automated APU ordering

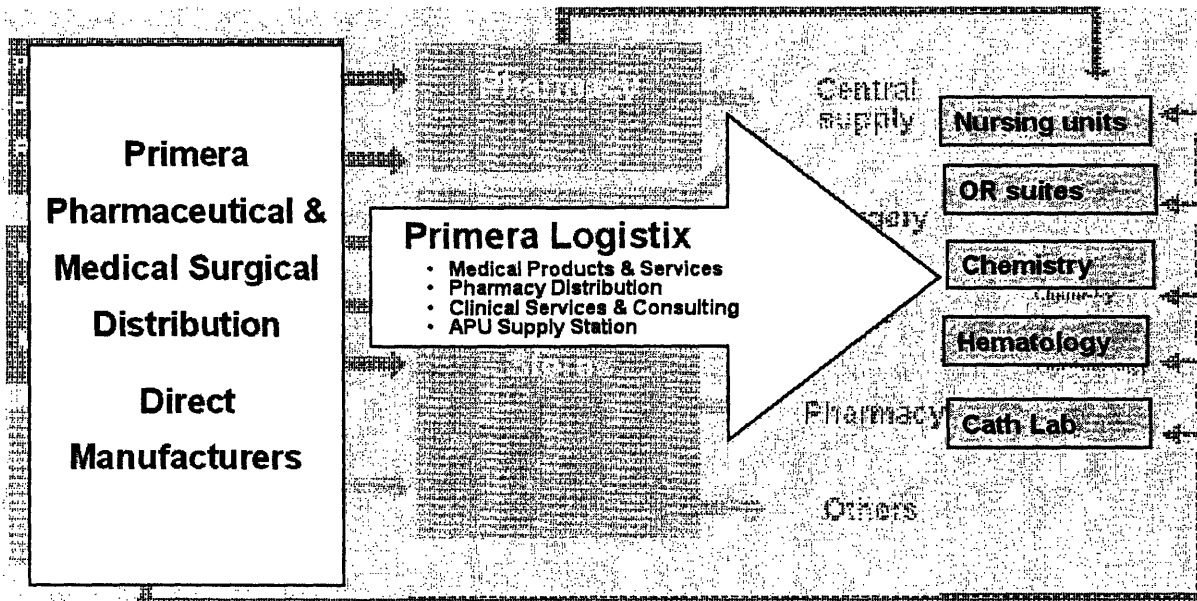


Figure 7: Primera Logistix functions (Source: modified from Primera documents)

4.3 Logistix Implementation & Operations

4.3.1 Preparations and Go-lives

In May 2005, BBC first announced the Logistix agreement with Primera within the organization, and at the same time, named two senior executives to champion the initiative: Senior VP of Clinical Services and Senior VP of Finance. Prior to the physical implementation of the APU stations in September, however, Primera trained several BBC personnel offsite as system “super users” who would become primary members of the implementation team. In addition, Primera consultants were also onsite at BBC to perform preparation tasks as specified in the agreement. As the centerpiece of the Logistix program, Primera appointed a Logistix manager who has extensive hospital material management experience to station fulltime at BBC as the central point of contact for all information and requirements flow between BBC and Primera. In fact, according to a Primera VP of sales, the Logistix manager position is central to all Logistix partnership programs. In some instances, the Logistix manager would even remain at the client’s request beyond the scope of the planned engagement.

In mid September, the physical implementation of the APU stations finally began in selected hospital areas. Primera and BBC decided to use a phased approach to APU station implementation. Phase I go-live, the current phase, initially planned to take 3 months, involved the satellite (Satellite 1) facility’s Operating Room (OR), In Patient (In Pt), Emergency Department (ED), and Endoscopy (Endo) departments, along with the main facility’s Cardiac OR, Urology OR, Plastics OR, GYN, Vascular, Endo, Intensive Care Unit

(ICU), Catheterization Lab (Cath Lab), and Electrophysiology Lab (EP Lab) departments. Phase II of the implementation would involve additional OR units along with nursing units, ED, and Anesthesia. In phase III, the plan is to have the APU stations in the clinics as well (Figure 8)

Phase I	
Satellite 1 complete	Main Facility
OR	OR Cardiac
In Pt	OR Urology
ED	OR Plastics, GYN, Vascular
Endo	Endo
	ICU's
	CL
	EP Lab
Phase II remaining Main Facility	
OR completion	
CVIR	
CNIR	
Nursing Units	
ED	
Anesthesia	
Clinics - Phase III	

Figure 8: BBC APU Implementation Phases (Source: Primera/BBC)

Immediately prior to go-live, according to the nurses, Primera would usually introduce a working APU station filled with candies for a period of time to make it fun for the nurses to get a feel for the real stations. In addition, Primera and the unit nurse manager usually would select a couple of nurses for training as unit “super users” who would be the first line system experts for other users. The larger units, such as, Endoscopy, OR, Cath Lab, and the Satellite 1 site, however, would have their own dedicated system administrators handling unit system administration functions, which could include unit personnel training and inventory tracking, among other tasks. Several unit system administrators even created reference manuals and

symbolic unit APU user certification exams to assist the clinicians in learning the APU systems.

On average the rollout of the APU stations to the units took about 3 days each to complete and the initial plan called for a rollout of Phase I over a three-month period. The actual rollouts, however, have been extended to allow for a smoother transition to the new system. The go-live date was usually set on a Wednesday to allow for operational adjustments in the two days leading to the weekend. Central Supply system administrators, acted as project “super users”, usually configured the APU stations for operation with help from unit nurse managers and Primera consultants. In addition, these administrators had been helpful at gauging the pulse of the nursing organization through the feedback they received on the APU system even beyond the implementation event.

4.3.2 APU Operations

Once the APU stations were live, the nurses were expected to use the machines as they had been trained. Except for the initial implementations, such as, the SICU, main facility project system administrators had not spend much time beyond go-live in assisting daily APU operations except when a station malfunctioned (although the administrators are constantly in touch with the refill technicians who are on the unit floor everyday). Unit system administrators and super users, however, were there to help with the day-to-day operations. For the Satellite 1 location, however, the system administrator was also the refill technician until mid March, when a refill technician was hired to perform that function.

After the rollout of the APU stations, nurses could expect some process changes in their patient care routines. Some changes were quickly embraced while others met open rejection. The changes that were embraced were usually the ones that had benefited the nurses, such as the nurses in some units were no longer required to stay after their shift to stock the shelves. Meanwhile, the changes that were rejected were usually the ones that had increased task complexity or changed task routine for the nurses, such as changing the item take procedure or changing the location of an item needed for a procedure. Further details on process change and how that affects nurses can be found under section 4.4, Nursing Feedback.

Once implemented, to access the APU station's products, the user used both a touch screen keypad to enter a login ID and biometric fingerprinting as the password. The APU allowed the recording of items taken and returned via the pressing of a button located near the corresponding bin. If the user was not sure of the location of the item he or she could actually search for the item on screen and a light would flash near the bin where the item should be located. If the door of the cabinet was left open for an extended time, for security, a voice reminder had been set up to remind the user to close the station door. In an emergency situation, however, pre-authorized users would be allowed to leave the door open for others to quickly access the needed supplies.

The restocking of supplies occurred early in the morning from Monday through Friday, based on prior night's data feeds from the APU stations to Primera warehouses (passed through both BBC and Primera information systems). Primera delivered the appropriate totes from its warehouses to BBC Central Supply, and from there, BBC refill technicians would take the

totes to the units and restock the APU stations. While restocking, the refill technician would also be performing a physical inventory of the stations to check for discrepancies. On average, restocking a unit usually took about 15 to 20 minutes. Because of the presence of multiple stations in some units, however, restocking could take up to three hours, according to one nurse manager, and had caused nurses to sometimes “step over” the technician to get to the supplies.

Unlike Baxter’s initial VMI programs that restocked seven days a week, the Logistix program at BBC ran on a five-day-a-week schedule with no weekend deliveries. This initially required the administrators to carefully configure the APU station’s par levels to allow for a three-day weekend (Friday through Sunday) without stock-outs. Through the end of March, a number of weekend stock-outs had been noted. To mitigate the stock-outs, as of May, Central Supply had been providing weekend replenishments, but this service would eventually be discontinued after the APU stations are fully implemented in all units. In speaking to a Central Supply system administrator, it seems that Central Supply had been setting expectations by actively communicating to the departmental users that the replenishment service would eventually go away. New efforts are, however, currently under way to completely eliminate the problem of weekend stock-outs by re-adjusting the par levels to match a full 4-day supply. In addition, to compensate for the 4-day par level, plans are also being considered to decrease the 5-times per week delivery schedule to 4 to decrease costs. Further descriptions of the 4-day par level issue can be found under section 4.5.1, Delivery Schedule.

An overall Logistix program workflow diagram at BBC can be viewed in figure 9. Note that, in late March, another feature of the Logistix program had been rolled out at Satellite 1 – the procedure based kitting service (PBK). However, this service was not yet online at the main facility and the kits were not yet stored in the APU stations.

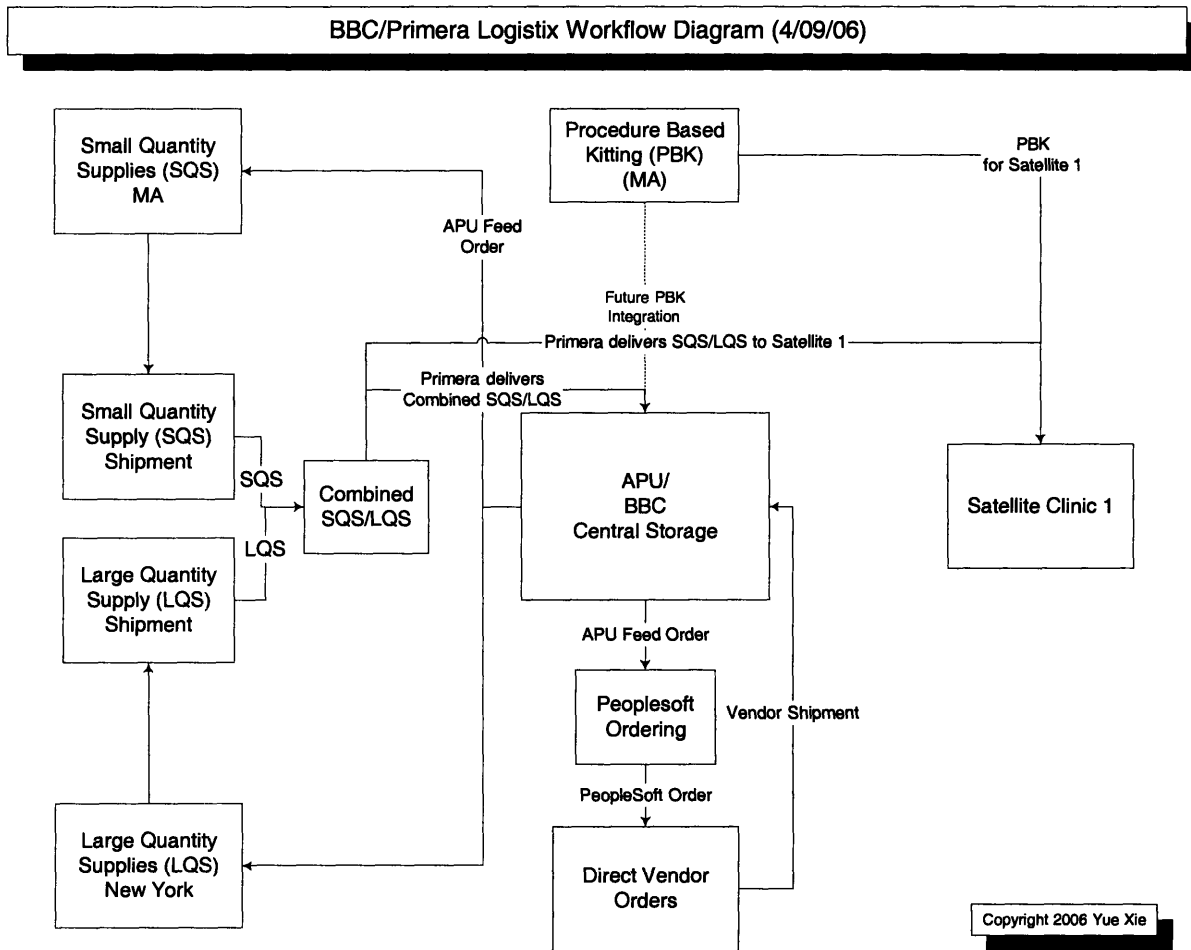


Figure 9: BBC/Primera Logistix Workflow Diagram

Another feature of the Logistix program is that special ordered items, such as cardiac stents for the Cath Lab, can also be ordered through the APU station and be placed alongside of Primera supplies. However, in this case, instead of sending the order information to Primera, the APU system would collect the order information and then send it electronically to BBC's

internal Peoplesoft financial system for order processing, and the items are delivered direct from manufacturer to BBC. As of March, an issue had arisen over the integration of the APU system to BBC's internal financial system with regard to order processing. It seems that prior customization of BBC's system may have contributed to the integration issue and led to different products from the same manufacturer being ordered and delivered on separate invoices and in separate boxes instead of on a single invoice and in the same box. Not only did this result in additional work for the units to restock special order items, but it also worsened BBC's lack of space situation. With multiple boxes, daily delivery of orders caused boxes, both opened and unopened, to stack up in the hallways of the units. Both Primera and BBC were aware of this issue and were working on a resolution.

4.4 Nursing Feedback

4.4.1 Interview Population Characteristics

In all, the author conducted individual face-to-face interviews with 14 nurses and nurse managers from across BBC. Given there are approximately 850 nurses at BBC, 14 nurses represent about 1.65 percent of the total nursing population. Departments involved in the interviews, all a part of the Phase I implementation, were Cath Lab, MICU, CCU, SICU, Endoscopy, Satellite 1, and several Med-Surg units. In addition, two nurse managers provided further feedback on process changes and statistical data usage.

At the time of the interview, of the 14 nurses and nurse managers (all RNs), the average length of their nursing career was 16.98 years with a median of 19. The maximum was 30,

while the minimum was 9 months (Appendix B). Of the 6 nurse managers in the sample, the average number of years spent, as nurse manager (not necessarily at BBC), was 5.15 with a median of 4.5. The maximum was 13 years, and the minimum, 5 months. Of the 9 nurses or nurse managers who reported their length of employment at BBC, the average length was 9.1 years and the median was 6 years; the maximum was 20 years and the minimum was 8 months. There was 1 male nurse in this population, which is about 7 percent of the total; closely resembles the 6 percent national figure. The author did not attempt to ask the age of the interviewees, but general observations seem to indicate consistency with the hospital-wide nursing average age of 43. Although the average number of years of nursing was only 17 years, several of the nurses expressed that nursing was their second career, which may explain the observed age of the sample population. Finally, 8 out of the 14 interviewees, or 57 percent, had prior experiences with medication APUs, but not APU supply stations.

4.4.2 BBC Nursing Environment

In many ways BBC's nursing staff is facing the same issues as others in the nation. The average nurse's age at BBC for 2005 was 43, while for 2004, it was 39. It is a national trend that has been captured by both BHP (2002) and Buerhaus (2003) indicating that the nursing population is getting older and that the recent trend in filling nursing vacancies has been with older nurses returning to the workforce. The reasons for older nurses returning to the workforce may be varied, but one older nurse reported that, she has returned to nursing because, for the first time, nursing is finally paying well and she is now able to afford nice things for her grandchildren.

When asked, all 14 interviewees reported that they love nursing. However, they were concerned that there is a nationwide shortage of nurses while the acuity level of the patients that they were seeing was much higher than just a few years ago, which required that they spend more time on patient care. One critical care unit nurse commented that, “a few years ago, these patients that (one sees) here would have died,” but instead, advancing medical technology has kept them alive, but ill and with high acuity levels. Not surprisingly, another common concern reported was stress related to nursing.

Unlike other hospitals, however, BBC does not seem to have a nursing turnover problem according to its staffing statistics. The average 10-month turnover rate for the entire nursing staff in 2005 was only 1.45% with fairly little variations in both departmental turnover and monthly turnover (Figures 10, 11). The lowest average turnover rate for this period was observed in Department 6, a Med-Surg unit, at only 0.68%. The highest, Department 8, was another Med-Surg (Medical-Surgical) unit, at 2.12%.

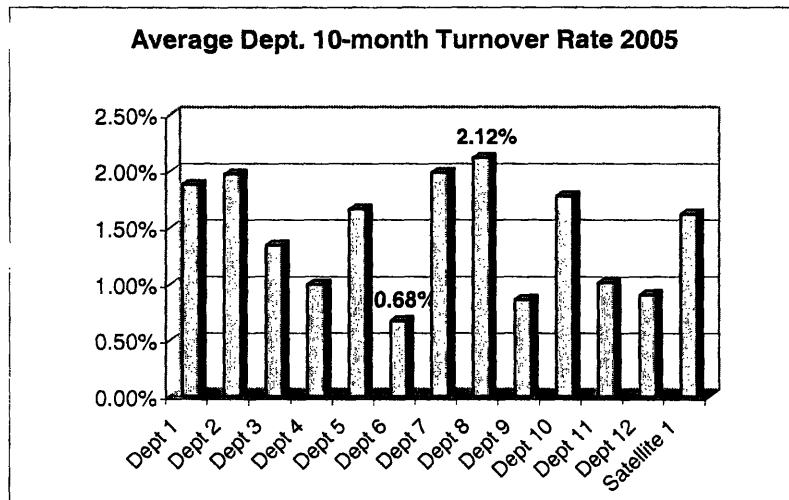


Figure 10: 2005 Average 10-Month Department Turnover Rates

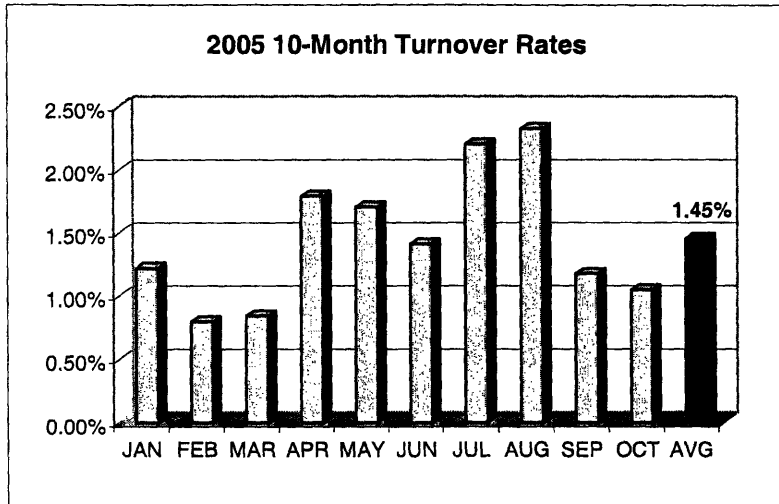


Figure 11: 2005 10-Month Average Turnover Rates

The responses to author's question on how satisfied the nurses are with their jobs seem to correspond with the low turnover rates at BBC as well. Of the fourteen responses collected, with satisfaction rating from 1 to 5, and 5 being the most satisfied, there were four (4) with ratings of 3, nine (9) with ratings of 4, and one (1) with a rating of 5 (Figure 12). That is an average job satisfaction rating of 3.78 out possible score of 5. It seems that the nurses are relatively satisfied and do not wish to leave BBC.

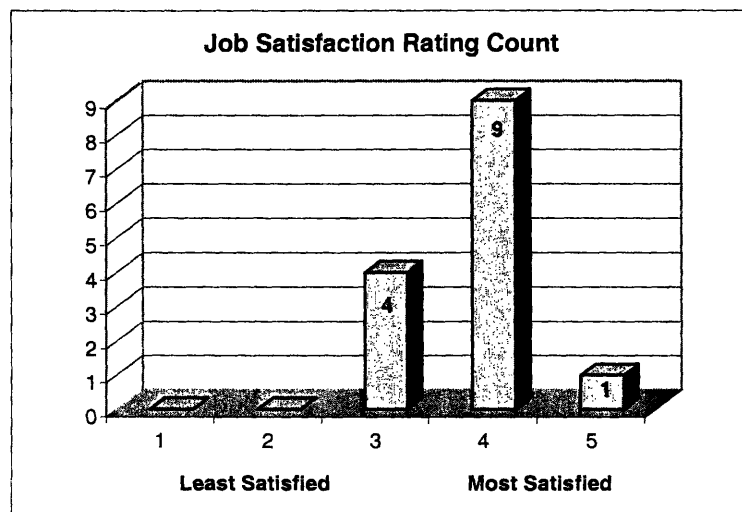


Figure 12: Job Satisfaction Rating Count

Looking at nursing vacancies, however, hospital-wide the average monthly vacancy rates for the first 9 months of 2005 ranged between 8 percent and 12 percent with higher vacancy rates experienced over the latter half and closely resemble AONE's (2002) 10.2 percent national RN vacancy numbers (Figure 13).

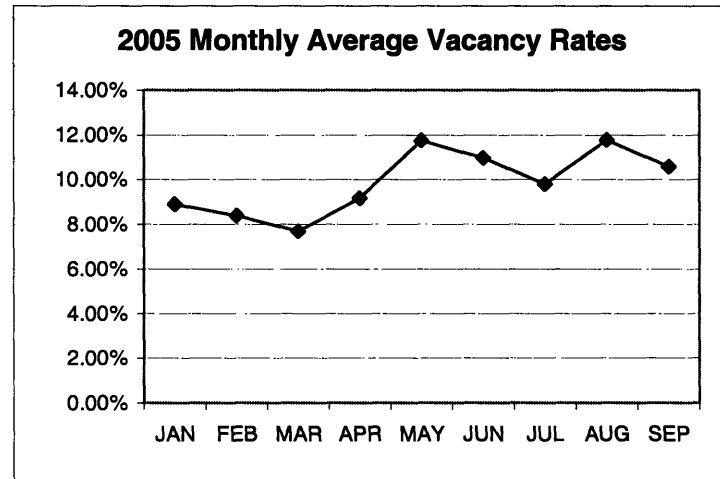


Figure 13: 2005 9-Month Monthly Average Vacancy Rates

In addition, there were also considerable variances in vacancy rates between BBC departments that were not observed with turnover rates (Figure 14). Overall, with the exception of Critical Care Unit B (CU B), which had a 9-month average vacancy rate of 15.51%, critical care units do not seem to be as affected with vacancies, which is consistent with one nurse manager's comment that nurses usually like challenges and vacancies had not been a problem for her critical care unit. This comment seems to also hold true for the BBC's Med-Surg units where the work may not be considered as challenging. There, a third of the units (3 out of 9) showed average 9-month vacancy rates of between 14% and 20%. Finally, one notable unit that seems to stand out in having the lowest average vacancy rate is Satellite 1. Here, the 9-month average vacancy rate was only 0.69% as compared to the hospital-wide

average of 9.74%. This is fairly consistent with the author's interview findings that Satellite 1 nurses were very happy about where they were, and they preferred Satellite 1's work location and work environment more so than the main facility and much more so than other hospitals.

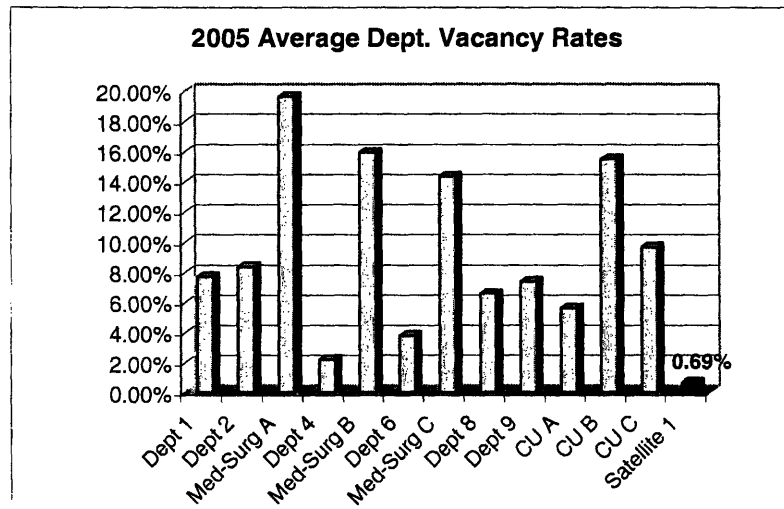


Figure 14: 2005 9-Month Average Department Vacancy Rates

Unlike the critical care unit nurse manager, however, the increasing trend of average monthly vacancies combined with increasing patient acuities did seem to be sources of concern for other nurses and nurse managers. Some nurses commented on experiencing both physical and mental stress with the increased workload. For nurse managers, one commented on the difficulty of finding qualified personnel for her unit, while another commented that job stress in her unit had consistently caused turnover and the remaining nurses had had to “step up” to the task.

Overall, even with the stress, nurses at BBC were generally happy with their jobs and their work environment. They felt that BBC was much better than other hospitals that they had

worked at and they pointed to the friendly co-workers and respect among peers as the major sources of their happiness. However, when asked what would they wish to improve upon the already pleasant conditions of BBC, the most common answer was that BBC was a physician centric organization and that nurses' concerns had sometimes gone unheard. One nurse felt particularly distressed that the physicians in her unit did not think the problems with the APU implementation were their concern. She felt that the physicians were insensitive toward the difficulties that the nurses were facing with the supplies. "They (the physicians) just want what they want when they want it." Other concerns commonly shared by the interviewees were their uneasiness for the rapid growth of the organization and the trend towards being less personal and more "corporate."

4.4.3 APU Feedback

There were a total of 16 nurses interviewed on topics specifically related to APU stations. Of these 16, 14 provided individual face-to-face interviews, while 2 provided email feedbacks on specific APU process related issues. Of these 14 that provided face-to-face interviews, a list of questions ranged from job satisfaction, to APU satisfaction, to prior system satisfaction, to the implementation process were asked (Appendix A), and the answers were recorded in writing. In summary, 12 of the 14 face-to-face interviewed nurses were in units that had live APU stations at the time of the interview, and the other 2 were in units that were ready to go-live within two weeks time. In addition, with the exception of 1 nurse, who had only had the APU stations for 2 weeks in her unit, the others all had had stations for 4 to 5 months.

Overall, when asked if the information about the APU stations given prior to the installation of stations in their units were adequate and, or accurate, all said the information was correct, but many at the main facility felt the information given was too general, or they were under-informed. This seems to collaborate with what the author observed first hand that there were little project level periodic updates that communicated APU information and implementation progress. All at the Satellite 1 facility, however, felt that the amount of information was adequate, and the nurses credited the unit system administrator for doing a good job at explaining and providing great training. Then again, many at the main facility felt that not much training was given and they could use more training for more people; several mentioned it was “on the job training.” The only observable difference between the main facility and Satellite 1, that the author could conclude, is that the system administrator at Satellite 1 was young, energetic, and had relatively little prior materials management experience at BBC that would contribute to preconceived bias for either the new system or the old. On the positive side, one younger nurse commented that the system did not require much training. In addition, for the units that received the demonstration APU station filled with candies as a training tool, everyone thought it was a great and fun way to get the nurses familiarized with the stations.

Overall, when the nurses were asked if they had supported the implementation of the APU stations prior to the implementation, 5 out of 14 (35.7%) said no, 2 (14.3%) had concerns, and 7 (50%) said they had supported the idea. The reasons for not supporting the APU system ranged from not willing to change, to “a little scared,” to concerns for accessibility in the critical care units. However, both those that had supported the implementation and those

who had not said that they felt it was a good idea to be able to capture the charges and bill the patients properly.

What the author found surprising is that prior experiences and support for the medication APU system did not automatically translate in to support for APU supply stations (Table 3). Of the 6 nurses who had prior medication APU experience, all were positive toward the experience. However, when asked if these 6 nurses supported the idea of using APU supply stations in their units when they first heard the announcement, 2 said they were strongly against it, and 1 had strong concerns (Table 3). Of these three that did not support the APU stations initially, two were from the critical care units. Their comments were along the line of concern for accessibility in the critical care environment and disliking change.

Nurse	Original Support	Prior APU Experience	Positive Experience
1	No	Meds	Yes
2	No	No	-
3	Yes	Meds	Yes
4	No	Meds	Yes
5	No	No	-
6	Yes	No	-
7	Yes	No	-
8	Yes	Meds	Yes
9	Yes	Meds	Yes
10	Concerns	Meds	Yes
11	No	No	-
12	Concerns	No	-
13	Yes	Meds	Yes
14	Yes	No	-

Table 3: Medication APU Experience and Support for APU Supply Station

The good news for APU system implementation is that opposition from the start does not necessarily translate to dislike of the system after it is fully implemented. Then again, support for the system in the beginning is not a guarantee for a successful implementation either. When asked to rank how much they liked the new APU stations from 1 to 5, with 0.5 unit scales and 5 being the most satisfied, of the 12 nurses whose units are live, one (1) rated it 1, three (3) rated it 2, two (2) rated it 2.5, three (3) rated it 3, two (2) rated it 4, and one (1) rated it 5 (Figure 15). The average rating for the APU system was 2.83 (out of 5), slightly below the midpoint (3) of the scale. The range of satisfaction, however, was wide, from 1 to 5. It seems that some units were doing very well, while others were doing poorly. For those 5 nurses that initially supported the APU implementation, their average satisfaction rating was 2.6, slightly below the midpoint. Surprisingly, the average satisfaction score for those 5 that were initially against it was actually higher, at 3.2 (Table 4).

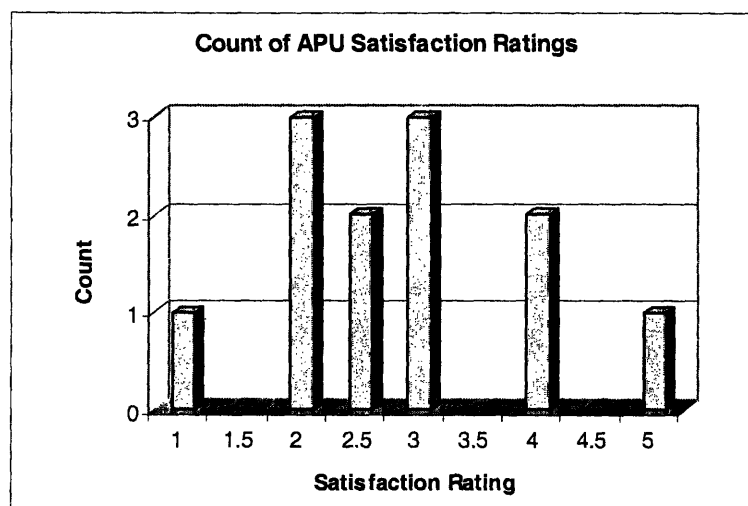


Figure 15: APU Satisfaction Count

Original Support	No	No	Yes	No	No	Yes	Yes	Yes	Yes	Concerns	No	Concerns	Yes	Yes
APU Rating	4	4	2.5	1	2	NA	2.5	2	NA	2	5	3	3	3

Table 4: Original Support and APU Satisfaction Rating

Although BBC Materials Management was highly confident that the system it had in place was excellent in meeting the needs of the clinicians, the surprise here is that the ratings given by the nurses seem to suggest that the old system was just adequate. Of the 14 nurses interviewed, the average satisfaction rating for the old system was 2.89 out of 5 on the same scale as the APU system. That is only slightly better than the 2.83 average rating of the new APU system (Appendix B).

Since support for the medication APU system was not a predictor of support for the APU supply station, what was then? In evaluating the interview data from the units that gave the new APU supply station system a higher score than the old system, the single-most consistently important factor across these units is whether or not there were accompanying workflow process changes that made the jobs of the nurses easier (Table 5). For example, at one unit, in the past the nurses were required to put in unpaid mandatory overtime after their work shift to administer the supplies. However, after the implementation of the APU stations the nurses were no longer required to handle the supplies in overtime, and therefore, they were more satisfied with the new system than the old. Another example is that, in some units nurses were required to order specialty supplies in the past, and after the implementation, the APU stations were generating the orders for them. In this case nurses too gave higher ratings for the APU system than the old. And finally, at a critical care unit, after the supply layout

and the location of the APU system was redesigned by the nurses, the unit saw drastic improvements in nursing satisfaction over the initial implementation that did not involve nurses in supply configuration and required the nurses to change their work behavior. After the nurses were involved in making the changes, the nurses rated the new system a 5 and a 3, both higher than the 3 and 2 that were given to the old system.

Nurse	APU Rating	Old System Rating	Process Change Helped
1	4	3	Yes
2	4	2	Yes
3	2.5	2.5	-
4	1	3	-
5	2	4	-
6	NA	4	NA
7	2.5	3	-
8	2	4	-
9	NA	1	NA
10	2	3	-
11	5	3	Yes
12	3	2	Yes
13	3	3	-
14	3	3	-

Table 5: Process Changes and Systems Rating

One of the original theories of this author was that, perhaps, high level of supply chain automation satisfaction would lead to high nursing job satisfaction, and low level would lead to the opposite. However, regression analysis of both APU system satisfaction score and nursing job satisfaction showed that APU system satisfaction was not a good predictor of nursing job satisfaction (R^2 of 0.21, Appendix C). Perhaps a larger sample size and additional variables, such as, vacancy rates, administration support ratings, among others would be more accurate. Also, a more encompassing longitudinal study including survey ratings of job satisfaction both before and after the implementation would help as well.

An embedded objective of this study was to examine whether or not the implementation of the APU supply stations had saved time for the nurses through the automation of supplies. As expected, when asked, the units where there were positive process changes, the nurses mostly felt that the new system had saved them time by freeing them from handling supplies. Whereas in the units where the ratings of the new APU system were lower or equal to the old system, the amount of time spent on supplies as indicated by the nurses was more or equal respectively (Table 6).

Nurse	APU Rating	Old System Rating	Time on Supply (APU v. Old)	Time on Patient Care (APU v. Old)
1	4	3	<	=
2	4	2	<	=
3	2.5	2.5	<	=
4	1	3	<	=
5	2	4	=	=
6	2.5	3	>	=
7	2	4	>	<
8	2	3	>	<
9	5	3	<	=
10	3	2	=	=
11	3	3	=	=
12	3	3	=	=

Table 6: Systems Ratings and Time Spent on Supplies and Patient Care

What is surprising, however, is that, in some instances, although time savings were observed, the nurses still gave lower or equal ratings for the new APU system versus the old system (Table 6, Nurse 3, 4). In the study, the nurses who gave lower ratings were specifically concerned with the perceived lower quality of the products supplied by Primera as compared to previous products, the five-day-a-week delivery caused weekend stock-out issue (details can be found under sections 4.3.2 and 4.5.1), and in the case of a critical care department, the

nurses felt that the new APU stations hindered their abilities to quickly access the supplies to care for patients. Based on the comments provided by the nurses the author concluded that, in addition to time savings, nurses considered the quality of the products, the availability of supplies, and the accessibility to supplies as the most important factors relating supplies to the quality of patient care. Given that what nurses really care about is delivering care, these four factors together contributed to their satisfaction ratings of the APU system (Figure 16). On the positive side, however, the critical care nurses also suggested that if the placement of the products in the cabinets could be procedure based, meaning items for the same procedure arranged close together for quick access, it would definitely increase product accessibility and produce timesaving, and therefore increase their satisfaction level.

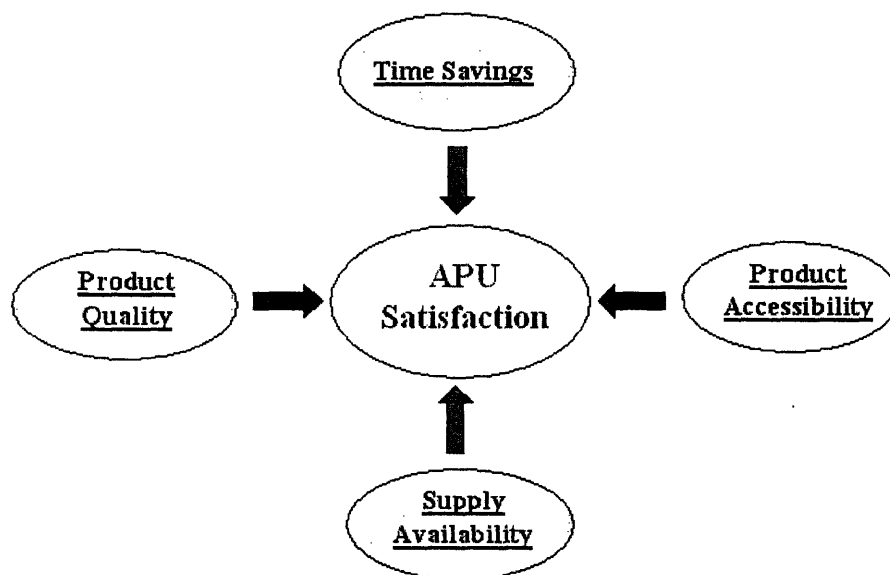


Figure 16: 4 Contributing Elements of Clinician Perceived APU Value

Another question that the author was interested in finding an answer for was whether or not time savings provided by automation of supplies would increase the amount of time that the

nurses would spend with patients, and therefore, would lead to increased quality of patient care. In general, most nurses, including those who felt that the APU system had saved them time with regard to supplies, felt that there was no change in the amount of time they had spent on patients as compared to before the APU implementation (Table 6). In fact, the only reported changes in time spent with patients were by those nurses who were clearly frustrated with the APU system and had commented that the APU stations had increased their time with supplies and decreased their time spent on patients. For those who did not report a change in time spent on patients, it is the author's feeling that it is possible that the nurses placed a great deal of pride in providing excellent patient care, and regardless of the system in place they may feel that they would spend the same amount of time to care for their patients. Therefore, it may be difficult to access the quality of patient care through asking nurses the amount of time they spend on patient care. Perhaps, in a longer termed study, collection and analysis of objective quality indicators both before and after the implementation would better answer this question.

Overall, based on the compliance data collected by the APU system over a 5 months period (from October 2005 to February 2006), it seems that more units were stabilizing. One measurement that was tracked, activity compliance, which is performing proper procedures when taking an item, was mostly in the 90 plus percent range for the units that had been live for 4 months or more. However, quantity compliance, meaning actual quantity taken versus what is tracked by the computer, was still in the seventy percent range for most units. In general, the nurses had commented that they were getting used to the APU system over time. In addition, some units that had great difficulties in using the APU system also had

undergone or were undergoing station redesigns to better accommodate the way the units worked. Looking forward, 6 of the 12 nurses who had the APU system in place were optimistic that they will spend less time with supplies in the future. Others, however, thought that they had already reaped the timesaving benefit because of their successful implementation. Then, there were a few that thought the APU system was not a fit for their units, especially those nurses in the emergency or critical care areas who considered accessibility paramount to patient care, and did not project further timesaving.

4.5 Miscellaneous Feedback

This section includes interview responses and observations that did not fit into specific topics of other sections of analysis, however, the author believes that these are nevertheless useful within the overall scope of the study.

4.5.1 Delivery Schedule

One of the most mentioned APU related issues that concerned the nurses across all units was the 5-day-a-week delivery schedule. This issue not only caused stock-outs on the weekends, but it also caused stock-outs for weekdays because the weekend inventory data were only submitted on Monday, which meant delivery of products would only occur on Tuesday, and therefore left supplies on Monday extremely low. That is why it was a 4-day weekend problem. This issue was so pervasive, even the nurse who gave the new system a rating of 5 admitted that it concerned her. In response, Primera consultants were working closely with BBC in March and April of 2006 to readjust the APU station's par levels to support a full 4-

day weekend. In addition, because the par levels are not independently adjusted for weekdays and weekends, there were also plans to decrease the delivery schedule from 5 times a week to 4 times a week to hold down costs.

4.5.2 Data Collection and Display

Like other hospitals, in addition to staffing data, BBC also tracks a number of clinical and operational measures, such as, “Hospital Acquired Pressure Ulcers” and “Hospital Admissions” statistics. However, also similar to most hospitals, none of these data are available on demand and in an easily accessible form. When asked what kind of data and how was the information received, one nurse manager described that she gets statistics separately from both the infectious disease team and the nursing office, and then she shares the information in her unit by posting the data on the bulletin board. Another nurse manager commented that she does get staff satisfaction surveys along with the clinical outcomes data, but the data were only generated either on a monthly basis or annual basis (for the staff satisfaction survey). She felt that this kind of information should be made available on a timelier basis and “as close to collection date as possible,” so that if there are negative trends in place she can address the problems more quickly.

4.5.3 Readiness

When it comes to Logistix implementation readiness, although Primera has implemented more than a dozen Logistix programs across the country, one BBC system administrator commented that Primera seemed to be implementing the Logistix program for the first time.

According to this administrator, each new phase of the Logistix program seemed to bring initial confusion, such as, incorrect picks that resulted in supplies not being delivered and led to nurses not trusting the APU system. However, the administrator also pointed out that Primera had always worked hard and brought the problems to resolution. To create positive initial perception and trust in the system, perhaps, a central repository of knowledge of Logistix implementation that would be retained and built upon by Primera and effectively applied could result in a smoother beginning for future implementations.

4.5.4 Cross-Facility Visibility

As a final note, one of the available features of the APU system is the cross-facility visibility of supplies that allows a nurse from one unit where there is a shortage to be able to lookup the needed supply on screen to see if it is available anywhere else on the APU system. This feature should enable the system as a whole to carry less inventory because of shared safety stock over the network. However, when interviewing one of the nurses, she specifically pointed to the locking ability of the new APU system that prevented users from other units to take items from her unit as one of the reasons she liked the APU system more than the old system. It seems that the old system mentality of hoarding still exists for the new system. Perhaps, for the most efficient use of the APU system, additional training would be needed periodically to correct this type of reflex behavior carried over from the old system and to positively reinforce the advantages that APU stations and Logistix offer.

5 Conclusions

In this era of heightened population and healthcare cost growth, the nursing profession is increasingly burdened with stressful work conditions that lead to high attrition and high vacancy rates in many hospitals. In turn, high vacancy rates increase the workload and stress level on the remaining nurses who are left to care for a population that is also increasingly older and sicker. Under these conditions, hospitals have gradually turned to supply chain automation as a way to both control cost and lessen the burden on nurses' non-patient care related workloads with the hope that it would allow the overworked nurses to spend more of their time on patients. As a supply chain specialist who also markets its own line of APU stations, healthcare supply distributor Primera is in a perfect position to provide the value that the hospitals are looking for by delivering its technology, its value added services, along with its supplies in a single solution package – Logistix.

This research was primarily motivated by the goal of trying to understand if relationships existed between successful automation and nurse job satisfaction, and between successful automation and patient care quality. To this end, Primera, a diversified leading healthcare supplier, and BBC, a respected New England area multi-specialty academically affiliated hospital, were engaged because of their on-going implementation of the Logistix program, a perfect environment for the study of supply chain automation and its effects on clinician satisfaction and patient care quality.

5.1 Research Findings

The Boston Globe in a recent article pointed out that the State of Massachusetts predicts that by year 2010 there could be a shortage of 10,000 nurses statewide and this number may eventually increase to 25,000 by 2020 (Contreras, 2006). Although current levels of vacancy and turnover rates do not yet appear to pose problems for BBC given the high job satisfaction ratings (3.78 out of 5) of the nurses interviewed, nevertheless, with the region becoming ever more scarce of nurses, this may be an issue that hospitals, such as BBC, should be concerned with. Already there are some signs that indicate that the patient acuity levels at BBC has gotten higher over the recent years and the nurses are becoming more concerned about the stress that is related to higher acuity levels.

Although the general objective of the Logistix supply chain automation program was mainly financial in nature, however, freeing nurses from managing supplies and allowing them to dedicate more time to patient care was also a focal point of both Primera and BBC. It is the conclusion of this study, then, that timesaving, a value-add to nurses, is achievable through supply chain automation, however, it succeeds only when implementation initiated process changes were designed with the involvement and support of the nurses who are the frontline users of the automated supply stations. In other words, success of the implementation depends on adding tangible value that helps the nurses, but to succeed the implementation must first get buy-in from the nurses. More importantly, however, it is the central finding of this study that although timesaving is an important element in perceived value, it is only one of the four elemental values that nurses perceive as important measures of overall satisfaction

of supply automation. Together, these 4 elements of clinician perceived supply automation values that contribute to overall APU Satisfaction are (Figure 16):

- Timesaving in managing supply
- Perceived quality of the products (Product Quality)
- The availability of supplies (Supply Availability)
- The accessibility to supplies (Product Accessibility)

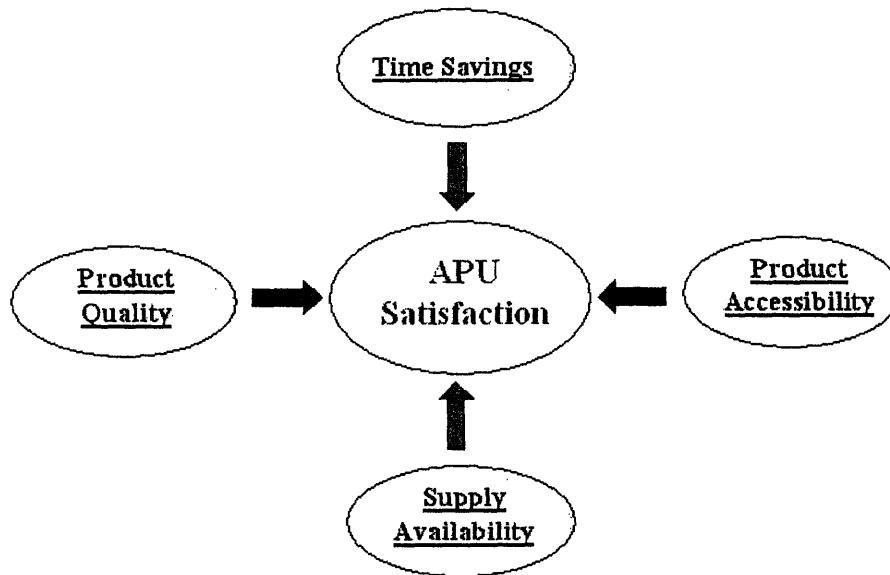


Figure 16: 4 Contributing Elements of Clinician Perceived APU Value

Therefore, for supply chain automation to fully succeed in hospitals, it is the task of the implementation team to design process changes that maximize these 4 elemental values. In addition, it is also the job of the implementation team to tailor these values to the individual units by maximizing what is most important to the unit; e.g., product accessibility, which is how quickly can the nurses access the supplies from the APU, may be the most important value for emergency room nurses.

One of the original hypotheses of this study was that perhaps supply automation satisfaction (APU Satisfaction) could be used as a predictor of nursing job satisfaction. Unfortunately, regression analysis showed that APU Satisfaction was not a good predictor of nursing job satisfaction (R^2 of 0.21). Perhaps a larger sample size and additional variables, such as, vacancy rates, administration support ratings, among others would provide more accurate predictions. Also, a more encompassing longitudinal study including survey ratings of job satisfaction both before and after the implementation would help as well.

Finally, it was also the goal of this study to answer the question of whether supply chain automation could increase patient care quality by freeing clinicians from supply management and allowing them to spend more time on patient care. However, the study finds that nurses are proud caregivers, and subjective survey question asking the nurses if the automation has given them more time for patient care yielded responses of no increase in time spent on patient care even when timesaving for supplies had been observed. Perhaps, a longer termed study involving objective clinical quality measurements from both before and after the implementation would yield a better result.

5.2 Recommendations

Based on conclusions reached through extensive interviews and in-depth analysis, the author would like to offer the following recommendations for Primera, BBC, and any hospitals in general that are facing similar implementations:

1. Both Primera and BBC must work closely together to find process changes that add tangible value that are based on the 4 elements mentioned in the findings section; some examples that may or may not have been addressed, and should be carried out early in the implementation process wherever possible, are:
 - **Accessibility:** Design the supply lay out of the critical care units' APU stations to be based on procedures so that nurses could quickly access the supplies, and therefore decrease concerns for accessibility; in the future, perhaps the APU stations can also be designed to be accessed by radio frequency cards, such as those available on luxury automobiles, that the nurses would wear and allow the opening of the stations without entering keys or using biometric fingerprints
 - **Product Quality:** Showcase supply quality through product demonstrations, and at the same time, provide a degree of choice for the nurses to pick supplies, such as gloves, among the different brands that Primera carries
 - **Supply Availability:** Readjust the par levels to adequately supply weekends, and educate users the value of the cross-facility visibility functionality of the APU system; in the future, based on user feedbacks, perhaps the APU stations can also accommodate user created search fields that can be individualized

2. In the process of creating value, the implementation should:
 - Always involve nurses in decision making to get buy-in and create trust
 - Be proactive in searching out resistance and demonstrate effort in providing timely solutions for problems that caused resistance
 - Improve organizational communication between administration, implementation team members, nurses, physician, and anyone else who is interested in the

implementation through frequent progress updates, such as, a monthly implementation news letter, periodic cross-unit super user meetings to share ideas, and physician-nurse-materials management roundtable discussions

- Emphasize that implementations are team efforts involving and affecting the organization from senior management, to physicians, to nurses, to material management personnel, and anyone in between; senior management should lead the way in bringing together the organization as a team
- Provide more training to more people in a well timed manner both prior to the implementation and after the implementation to increase user knowledge and realize additional value; e.g., sponsoring periodic friendly post implementation competitions that showcase how a skilled nurse can quickly and accurately take supplies
- Empower a system administrator who is energetic and motivated to learn the new system and not necessarily encumbered by the experience of the old system
- Create a knowledge base for APU implementation and usage and allow everyone to both access and contribute to it, and therefore, leveraging the collective knowledge of the entire organization to provide additional value; perhaps Primera should host this initiative and leverage the collective knowledge of all Logistix partnership programs
- Learn to fail or fail to learn – do not be afraid of initial failure; as long as both BBC and Primera work together as a cohesive team to learn from initial setbacks and continuously improve the overall process, ultimate success would follow

5.3 Future Possibilities

Although the survey of literatures did not uncover the future direction of supply chain automation in healthcare beyond the use of APU system, this author believes that, as more vendors and customers start to integrate both in process and in technology, the next step in supply chain automation in healthcare should go beyond the traditional realm of materials management related systems and services. With the advancement of information technology, the time is right for the healthcare industry to leap frog into the era of real-time information exchange of compatible systems that allow everyone, vendors and customers, executives and clinicians, to feel the pulse of the organization and allow strategic actions to be taken based on real-time key measurements that drive forward the goal of achieving high quality patient care with highly satisfied staffs and excellent financial return.

Increasingly, hospitals are turning to real-time dashboards to inform them of clinical measures. However, it is likely that hospitals are also interested in knowing their key inventory levels and how satisfied their employees and patients are in real-time. Large healthcare supply distributors, such as Primera, are naturally well suited to extend the APU supply stations into central hubs of hospital data that both collect and disseminate information so that real-time issue management becomes a realistic possibility. In exchange, Primera can add this capability as another value-add feature in the partnership formula and deepen the relationship between the supplier and the hospital in the long run.

There are, however, challenges that must be overcome before the information integration becomes a reality for both the supplier and the partnering hospitals. Currently, there are

myriad technology platforms that coexist in the hospital environment that offer little or no integration capability with other platforms. For information integration to succeed, an industry-leading supplier must take the thought leadership position and leverage the unique relationships that it has built with its hospital customers and create a common information integration platform similar to that of the ASAP program in concept. Perhaps, also similar to ASAP, this new initiative would usher in a new paradigm of truly integrated suppliers and hospitals in the healthcare industry that may rival that of the more heralded supply chains of Toyota and Dell.

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A Nurse Interview Questions

Section 1: Job satisfaction

1. How long have you been a nurse? Nurse Manager?
2. LPN or RN?
3. How do you like nursing as a career? Y/N
4. What are some of the problems that you see facing nursing today?
5. How long have you been at BBC?
6. If it is up to you what would you like to change about BBC?
7. On a scale of 1 – 5, how happy are you with your job? 1 – 5

Section 2: Feel of current system

1. Were you in support of the APU system when BBC announced it? Y/N
2. How did other nurses around you feel about the announcement of the new system?
Generally in support or against?
3. Do you have any prior experiences with APUs?
4. What do you like about the APU system?
5. What you don't like about APU system?
6. On a scale of 1-5, how much do you like the APU system?

Section 3: Feel of old system

1. What did you like about the old system? What about other nurses?
2. What did you dislike about the old system?
3. On a scale of 1 – 5, how much did you like the old system?

Section 4: APU implementation process

1. How much information did everyone in your department receive prior to the implementation of the APU system?
2. How much training did you get prior to go-live?
3. Do you feel that the information you received prior to go-live was correct?
4. Do you feel that more training/support will benefit you?
5. Is there any difference between how you do your work prior to and now? Is it an improvement?

Section 5: Nursing satisfaction/time

1. As compared to before APU, do you spend more time now with patients or less?
2. Do you spend more time with supply now or less?
3. If more time spent on supplies, what's taking your time?
4. What can be done better to free up your time?
5. Do you believe the quality of your work has increased/decreased with APU?
6. In the long run, do you believe that your time spent with supplies will decrease?

B Nurse Interview Results

Unit	Love Nurs'	Nurs' Yrs	Mgr Yrs	BBC Yrs	Job Satisfaction (1-5)	APU Rating	Old System Rating	Process Change Helped	Time on Supply (APU v. Old)	Time on Patient Care (APU v. Old)	Installed	Original Support	Prior APU Experience	Love Previous Exp.
1	Yes	20	NA	20	4	4	3	Yes	<	=	Sep-05	No	Meds	Yes
1	Yes	5	NA	5	3	4	2	Yes	<	=	Sep-05	No	No	-
1	Yes	30	NA	6	4	2.5	2.5-		<	=	Sep-05	Yes	Meds	Yes
1	Yes	20	NA	3	4	1	3-		<	=	Sep-05	No	Meds	Yes
2	Yes	0.75	NA	0.7	4	2	4-		=	=	Feb-06	No	No	-
2	Yes	29	0.4	NA	5	NA	4	NA	NA	NA	No	Yes	No	-
3	Yes	22	6	16	4	2.5	3-		>	=	Sep-05	Yes	No	-
3	Yes	18	13	NA	3	2	4-		>	<	Sep-05	Yes	Meds	Yes
4	Yes	3	NA	2	3	NA	1	NA	NA	NA	No	Yes	Meds	Yes
5	Yes	12	NA	9	4	2	3-		>	<	Oct-05	Concerns	Meds	Yes
6	Yes	22	NA	20	3	5	3	Yes	<	=	Sep-05	No	No	-
6	Yes	16	3	NA	4	3	2	Yes	=	=	Sep-05	Concerns	No	-
7	Yes	26	0.5	NA	4	3	3-		=	=	Oct-05	Yes	Meds	Yes
8	Yes	14	8	NA	4	3	3-		=	=	Sep-05	Yes	No	-
Average		16.98	5.15	9.08	3.79	2.83	2.89							
Max		30	13	20	5	5	4							
Min		0.75	0.4	0.7	3	1	1							
Median		19	4.5	6	4	2.75	3							

Not Installed
Process Change Helped

C Regression Analysis

SUMMARY OUTPUT ANALYSIS OF APU SATISFACTION RATING & JOB SATISFACTION RATING

<i>Regression Statistics</i>	
Multiple R	0.459315212
R Square	0.210970464
Adjusted R Square	0.132067511
Standard Error	0.421345043
Observations	12

ANOVA						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>Significance F</i>
Regression	1	0.474683544	0.474683544	2.673796791	0.133057714	0.133057714
Residual	10	1.775316456	0.177531646			
Total	11	2.25				

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	4.287974684	0.350765124	12.22463236	2.45337E-07	3.506421148	5.069528219	3.506421148	5.069528219
APU Rating	-0.189873418	0.116118113	-1.63517485	0.133057714	-0.448600741	0.068853906	-0.448600741	0.068853906

D List of Interviewees

Organizations	Interviewee (number of)
Primera	Logistix Source Manager
	Sales Vice President
BBC	Associate Chief Nursing Officer
	Director of Materials Management
	Nurse Managers (8)
	Nurses (8)
	System Administrators (5)
Primera Competitor	Senior Vice President, Operations
	Senior Vice President, CIO
	Senior Vice President, Consulting
	Vice President, Supplier Relations
Texas Hospital	President and CEO