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Assessing Industry Business Practices in Implementing Radio Frequency Identification (RFID) in the Tracking and Tracing of Pharmaceuticals

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By: Kevin E. Gangadeen
Bernadette D. Houston

December 2005

Advisors: Nicholas Dew
Ira Lewis

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ASSESSING INDUSTRY BUSINESS PRACTICES IN IMPLEMENTING RADIO FREQUENCY IDENTIFICATION (RFID) TECHNOLOGY IN THE TRACKING AND TRACING OF PHARMACEUTICALS

Kevin E. Gangadeen, Major, United States Air Force
Bernadette D. Houston, Lieutenant, United States Navy

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December 2005

Authors: _____
Kevin E. Gangadeen

_____
Bernadette D. Houston

Approved by: _____
Nicholas Dew, Lead Advisor

_____
Ira Lewis, Support Advisor

_____
Robert N. Beck, Dean
Graduate School of Business and Public Policy

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ABSTRACT

The purpose of this MBA project is to assess industry business practices in implementing RFID technology in the tracking and tracing of pharmaceuticals. Our project will focus on what was found during our research (to include interviews and site visits) which was quite different from what was portrayed by the media. Our analysis of a few organizations will identify what market leaders do when considering the implementation of a new technology into its business practices. Based on our analysis, we determined what patterns were common throughout the industry and what DoD should be aware of as it implements RFID technology in the tracking and tracing of pharmaceuticals.

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I. INTRODUCTION

A. BACKGROUND

The U.S. Department of Defense's (DoD's) military healthcare system has a problem. Since 2001, the cost of providing healthcare services to active duty, retired, and reserve service members has almost doubled. The current annual cost is around $37 billion dollars; of that, over $5 billion is expended for pharmaceuticals. The military healthcare cost is projected to rise to over $50 billion by 2010.[1]

A number of reasons can explain the increase in cost. For example, reasons include: 1) activation of TRICARE for Life in 2001; 2) increased activation of reserve components in support of Operation Enduring Freedom and Operation Iraqi Freedom; and 3) inefficiencies in (DoD's) supply chain management (SCM) of assets, such as pharmaceuticals. Currently, DoD is either studying or engaged in implementing a number of initiatives related to reducing medical care cost and increasing efficiencies in its SCM. RFID technology is one such initiative.

B. PURPOSE

The purpose of this MBA project is to determine industry best practices in implementing RFID technology in the tracking and tracing of pharmaceuticals. This project seeks to answer the question, "Can DoD benefit from considering the industry's best practices of implementing RFID technology in tracking and tracing of pharmaceuticals? By knowing this, DoD can possibly integrate RFID technology in a manner that does not force its suppliers to implement immature technology that does not optimize the opportunities to improve the quality of care provided to service members and their families through DoD's military healthcare system.

On July 30, 2004, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) released DoD's RFID policy and implementation strategy.

[1] Doug Sample, "Military Struggling with Rising Healthcare Cost," American Forces Information Service, (2005): par. 7, http://www.defenselink.mil/news/Apr2005/20050422_715.html, June 2005.

The policy stresses that RFID technology greatly improves the management of inventory by providing hands-off processing and minimizing time spent through the normal means of inventory processing. Additionally, RFID technology allows the improvement of data quality, asset visibility and maintenance of material. Basically, DoD believes that RFID technology will improve its business practices and ease many aspects of the DoD supply chain.

DoD's new RFID technology policy mandates its 60,000 suppliers/manufacturers to put passive RFID tags on the lowest possible packaging piece – part, case or pallet, beginning January 2005. The phase-in process will be based on commodity type, location, etc. and will end in January 2007. After January 2007, all products transported within DoD's supply channel will require RFID tagging. DoD acknowledges that this mandate will have a grave impact on its supplier/manufacturer stakeholders. Therefore, it continues to host RFID summits to provide guidance, offer alternative solutions, and answer questions to remove ambiguity in regards to each parties' role and responsibility in implementing the RFID initiative.[2]

C. HISTORY OF RFID TECHNOLOGY

RFID technology has over sixty years of history. According to Shepard, the most notable study done on RFID was completed by Harry Stockman in 1940. The study was titled "Communication by Means of Reflected Power," which was the first to give insight on the potential capabilities of RFID technology.[3] Goodwins adds to this insight by saying that RFID technology was actually first applied during World War II by the British. During the war the British needed to be able to better distinguish between friend and foe aircrafts. Therefore, transponders were planted on their aircrafts and their allies' aircrafts to clearly identify them as they returned to the area. An interrogator would pick up the signal from the transponder as the aircraft approached the area. The transponder would relay the aircrafts' identifying code back to the interrogator, which would then be

[2] U.S. Department of Defense, DoD Announces Radio Frequency Identification Policy, (Washington, DC: GPO, 2003), http://www.defenselink.mil/news/Oct2003.html, June 2005.

[3] Steven Shepard, RFID Radio Frequency Identification, (New York: McGraw-Hill, 2005), 42.

forwarded to the data center. This application of RFID technology is known as Identification Friend or Foe (IFF).[4] According to the Government Accountability Office (GAO), the Department of Energy advanced the usage of RFID technology when its Los Alamos National Laboratory developed a system to track nuclear substances being transported in and out of the laboratory. A transponder was embedded in the transporting trucks and an interrogator was implanted at the gates of the installation.[5] Today, we see this system in action at many of America's automated toll booths, known as E-ZPass.

D. OVERVIEW OF RFID TECHNOLOGY

RFID technology is evolving to be one of the fastest globally accepted technologies today. In William's report, he mentions that Applied Business Intelligence reported in 2002 that RFID tag usage was at 323 million units. Utilization is expected to grow to 1.62 billion units by 2008.[6] Supply and Demand reports that Datamonitor, an independent analyst, forecasted RFID technology to be a $6.1 billion global industry by 2010. The current market is around $3 billion.[7]

Shepard reports that an RFID system consist of three key components used to store and relay data. The first component is a transponder, also known as a tag, which is attached to the item to be tracked or identified. The second component is the reader, also known as an interrogator, which empowers the transponder to communicate with the database. The final key component is the database, which captures data and allows editing of the information coded on the transponder.[8]

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[4] Rupert Goodwins, "Old Technologies, New Possibilities," ZDNet, (2005): par. 1, http://insight.zdnet.co.uk/hardware/chips/0,39020436,39153971,00.htm, June 2005.

[5] U.S. Government Accountability Office, Information Security: Radio Frequency Identification Technology in the Federal Government, 2005 (Washington, DC: GAO, 2005), 4.

[6] David H. Williams, "Beyond the Supply Chain: The Impact of RFID on Business Operations and IT Infrastructure," Computerworld, (2005): par. 7, http://www.computerworld.com/printthis/2005/0,4814,101791,00.html, June 2005.

[7] Supply & Demand Chain Executive, "RFID Market to Exceed $6 billion Worldwide by 2010," (2005). par. 1, http://www.sdcexec.com/article_arch.asp?article_id=7199, June 2005.

[8] Steven Shepard, RFID Radio Frequency Identification, (New York: McGraw-Hill, 2005), 55.

The USD (AT&L) has identified active and passive RFID tags to be used within DoD. The active tags, which have an internal battery, have read/write capability, a large storage capacity, and a long readability range. The passive tag has read-only capability, a smaller storage capacity and a short read strength.[9] According to GAO, the cost of the RFID tags vary based upon the frequency used, storage capacity, design of the antenna, type of memory and more.[10] Table 1 provides a quick summary of the basic characteristics of the passive and active tags.

Table 1. Basic Characteristics of RFID Tags

	Passive Tags	**Active Tags**
Power Supply	external (from reader)	internal battery
Read Range *	up to 20 feet	up to 750 feet
Type of Memory	mostly read-only capability	read-write capability
Cost	$.20 to several dollars	$20 or more
Life of Tag	up to 20 years	up to 5 to 10 years
Source: National Institute of Standards and Technology and Robert W. Baird & Co., Inc.		

*Read range of the tag will vary based on interferences such as water and metal.

The RFID Journal adds that due to the passive tag not having an internal battery, it must receive temporary energy from the interrogator to relay data to the database. The active tag includes an independent battery, which allows the tag to initiate communication with the interrogator and relay data to the database.[11]

The key components work together to track, identify and store information on the product, and relay information to database. Many retailers such as Wal-Mart, CVS drugstore, Albertsons grocery store, and Ann Taylor apparel are currently placing RFID

[9] U.S. Under Secretary of Defense for Acquisition, Technology, and Logistics, Radio Frequency Identification (RFID) Policy, 2004 (Washington, DC: USD (AT&L), 2004), 1-1, 2-1.

[10] U.S. Government Accountability Office, Information Security, 8.

[11] RFID Journal., Glossary of RFID Terms, June 13, 2005, http://www.rfidjournal.com/article/articleview/208, June 2005.

tags on their respective products to track and trigger immediate replenishment of inventory and to quickly detect theft.

E. COURSE OF STUDY

To date, four other MBA professional reports were completed at the Naval Postgraduate School (NPS) that involved the usage of RFID technology within DoD's logistics chain.[12] The report completed in December 2003 focused on the technical attributes of DoD's RFID tags and infrastructure, Air Mobility Command's (AMC) legacy Automated Information System (AIS) known as Global Air Transportation Execution System (GATES), and AMC's role within its supply chain. The project completed in June 2004 placed emphasis on what a Supply Corps Officer is willing to pay for the increased benefits of RFID technology in support of the warfighter. In December 2004, Joaquin A. Sanchez et al., reported the many potential financial and practical benefits of RFID technology used in the management of medical equipment at the Naval Medical Center San Diego (NMCSD). The most recent report was completed in June 2005. The authors focused on DoD's power exercised in the development and application of RFID technology just as with the development of the Internet. Additionally, they show the correlation between DoD and RFID developments in the civilian sector.

As mentioned earlier, DoD plans to implement RFID technology in the tracking and tracing of its pharmaceuticals and medical equipment in January 2006. Our goal is to

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[12] The previous RFID MBA projects were completed in December 2003, June 2004, December 2004, and June 2005. See:

Hozven, Marcelo and Clark, George, "DoD Supply Chain Implications of Radio Frequency Identification (RFID) Use Within Air Mobility Command (AMC)," MBA Professional Report, Naval Postgraduate School, December 2003

Corrigan, Christopher and Kielar, Jayson, "The Value of Logistics Information to the Warfighter," MBA Professional Report, Naval Postgraduate School, June 2004

Sanchez, Joaquin A., Chavez, Sergio, and Nixon, Richard, "Medical Equipment Management through the Use of Radio Frequency Identification (RFID)," MBA Professional Report, Naval Postgraduate School, December 2004

Acevedo, Rafael A. and Cooper, Robert W., "The Extent of DoD Influence on the Development and Application of Radio Frequency Identification (RFID) Technology in the Civilian Sector," MBA Professional Report, Naval Postgraduate School, June 2005.

take a deep look at the pharmaceutical market leaders' implementation process and determine what we believe are the industry's best practices in implementing RFID technology into current business processes. Based on our findings, the project team will make recommendations to DoD about the industry's common patterns and concerns in the implementation of RFID technology. This will afford DoD the opportunity to quickly see what the industry is currently doing and refine its own implementation process, wherever necessary and feasible.

II. LITERATURE REVIEW

A number of potential applications can be identified for RFID technology. Texas Instruments reports that RFID systems can meet various business system needs of many industries such as the library, law firms, airlines, livestock, automotive, sports, logistics, retail, and healthcare.[13] This literature review focuses on some of the benefits in the healthcare industry. The Wireless News reports that the vice president of marketing for Omnicell, a patient safety solutions provider, mentioned a number of benefits from RFID technology. To name a few are more accurate tracking, easier and faster dispensing and replenishment, deterrence of theft, and elimination or significant reduction of physical inventory.[14]

A. APPLICATIONS

1. Surgery

McGee gives the account of hospitals adopting the new verification RFID system, Surgichip, in hopes of eliminating erroneous surgeries and increasing patient safety. As a part of preparing the patient for surgery, an adhesive Surgichip tag is placed in a visible area on the patient. Prior to beginning surgery, one of the operating room staff members will be required to scan the tag. The data on the tag will include a medical profile of the patient and the type of surgery required. Many hospitals see the investment of $9 per surgery as an avenue to increase patient safety and reduce the possibility of malpractice lawsuits due to erroneous surgeries.[15]

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[13] Texas Instruments, TI-RFid Applications, http://www.ti.com/rfid/docs/applications/applications.shtml, June 2005.

[14] Wireless News, "Omnicell Marketing Exec Outlines New RFID Medical-Surgical Supply Chain Management Technology," April 11, 2005, 1, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=820799881&sid=1&Fmt=3&clientId=11969&RQT=309&V Name=PQD, June 2005.

[15] Marianne Kolbasuk McGee, "RFID Goes to the OR," InformationWeek, (2005): par 2, 3, 5, http://www.informationweek.com/story/showArticle.jhtml?articleID=162100356&tid=13692, June 2005.

2. Blood Supply

Iyengar of Asia Times reports that China plans to use RFID technology to track its blood supply. In hopes of reducing the number of HIV and hepatitis cases derived from blood and organ transplants, China plans to place RFID tags on donated blood. China claims that the use of RFID technology to track its blood supply is another significant application of RFID technology.[16]

According to Allen, as a result of a number of deaths due to blood-type and patient mistakes, a few hospitals such a Massachusetts General Hospital (MGH) are taking the lead on implementing RFID technology in its blood supply. Patients will wear a wrist band embedded with an RFID chip that indicates their blood type. Sensors in the room will attempt to match the blood-type data given on the patient's wrist band and the blood-type data given on the bag of blood that has an RFID tag. If there is not a blood-type match between the two, a monitor will alert the medical staff with "Stop! No Match."[17]

3. Medical Equipment and Devices

Recently, Dave Pelland, an editor for KPMG (one of the "Big Four" accounting agencies) reported that hospitals are starting to expand integration of RFID technology to track expensive and highly utilized medical equipment such as EKG machines, defibrillators, and wheelchairs. RFID technology in hospitals can increase asset visibility, reduce down-time to search for needed assets, reduce shrinkage, and more. With a full RFID system in place, medical staff members can quickly locate assets via the usage of a ceiling-mounted or handheld reader. As a caveat, hospitals must ensure that RFID signals do not interfere with existing medical equipment that communicates with the nurses' stations through wireless technology.[18]

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[16] Jayantih Iyengar, "RFID in China's products, blood, and people," Asia Times, (2004): 14, http://www.atimes.com/atimes/China/FH14Ad02.html, June 2005.

[17] Scott Allen, "System Targets Blood-Type Mix-Ups," The Boston Globe, (2005): par 3, http://www.boston.com/news/globe/health_science/articles/2005/02/24/system_targets_blood_type_mix_ups, June 2005.

[18] Dave Pelland, "RFID Finding Role in Tracking Medical Center Assets," KPMG Technology Insider, (2005): par 1, 5, 11, 17, http://www.kpmginsiders.com/display_analysis.asp?cs_id=134174, June 2005.

Sanchez et al. recently completed an MBA professional study at the Naval Medical Center San Diego (NMCSD) and found that there are a number of potential benefits gained through the deployment of RFID technology in a military hospital. Better medical equipment management and tracking can harvest savings by avoiding cost of replacing lost or stolen equipment. Additionally, an RFID system has the potential of increasing productivity efficiency, meaning better utilization of personnel for other important task, since not as much time will be required to locate medical equipment.[19]

Swedberg reports that the King's Daughter Medical Center in Ashland, KY has begun to use the technology to track the addition and removal of medical devices from storage cabinets. The center has replaced its traditional cabinets with "smart cabinets," which have built-in interrogators that require nurses to use their proximity identification cards and keypunch the name of the patient for which the device is to be used to gain access. When the item is removed and the cabinet is relocked, the interrogator takes inventory and relays the data to the database, which routes data to appropriate offices, such as materials management, patient-care tracking, and billing. Eventually, this process will automatically produce a billing report for patients.[20]

4. Personnel

According to Doris Ryan with Bureau of Medicine and Surgery, the U.S. Navy researchers are testing the RFID-based Tactical Medical Coordination System (TacMedCS). This system is a wireless communication system that assists hospital corpsmen in capturing data to locate injured sailors and marines during combat. The key components of the TacMedCS are: 1) a plastic tag with an electronic chip embedded with personal medical information, 2) a palm-held scanner with chip read and write capability, and 3) a central server with a database and a digital map display of the combat areas.[21]

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[19] Joaquin A. Sanchez et al., "Medical Equipment Through the Use of Radio Frequency Identification (RFID)," (MBA thesis, Naval Postgraduate School, 2004), 63.

[20] Claire Swedberg, "RFID Heals Hospital's Inventory Problems," RFID Journal., (2005): 3, 5, 6, http://rfidjournal.com/article/articleview/1806/1/1/, June 2005.

[21] Doris Ryan, "FH-3 Tests Patient Tracking System In Iraq," Navy Newsstand, (2003), http://www.news.navy.mil/search/display.asp?story_id=7590, November 2005.

The TacMedCS is described as offering both medical and tactical benefits. The Naval Aerospace Medical Research Laboratory (NAMRL) says that by giving hospital corpsmen access to real-time status and location of casualties, medical assistance and evacuation of the injured can be provided more quickly. The TacMedCS can also serve as a planning tool. With warning in advance, medical personnel can quickly identify needed resources to address a specific injury. Another benefit of TacMedCS is the provision of situational awareness. The system can assist in identifying high casualty areas. This will allow tactical planners to supplement reduced forces in high incidence casualty areas more expeditiously.[22]

In 2003, Fleet Hospital Three deployed to Iraq as one of the test sites for the TacMedCS. Although medical personnel admitted that there were software problems that need to be worked out, overall it was believed that the TacMedCS had proven its worth by offering real-time injured sailor and marine tracking.[23] Currently, the complete implementation of the TacMedCS is unknown.

5. Pharmaceuticals

Tracking and tracing pharmaceuticals are vitally important to the U.S. Food and Drug Administration (FDA), manufacturers, distributors, and hospitals. As a result of a feasibility study released in 2004, FDA published its policy guidance for the pharmaceutical industry. FDA stresses that RFID technology can help fight against the increase in drug counterfeiting. Pfizer announced its plans to place RFID tags on bottles of the infamous drug, Viagra, this year. Purdue Pharma announced placing RFID tags on bottles of OxyContin, which has a high potential for abuse, theft, and diversion. FDA has strongly encouraged the pharmaceutical industry to adopt RFID technology by 2007.[24]

Tesoriero reports that Purdue Pharma plans to absorb an investment of $2 million plus around $.50 per tag in implementing and RFID system within its supply chain. As

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[22] Naval Aerospace Medical Research Laboratory, http://www.namrl.navy.mil/clinical/projects/tacmedes.htm, November 2005.

[23] Doris Ryan, "FH-3 Tests Patient Tracking System In Iraq," Navy Newsstand, (2003), http://www.news.navy.mil/search/display.asp?story_id=7590, November 2005.

[24] U.S. Food and Drug Administration, "Radio Frequency Identification Technology: Protecting the Drug Supply," March/April 2005, http://www.fda.gov/fdac/features/2005/205_rfid.html, June 2005.

an additional means of identifying stolen pharmaceuticals, Purdue Pharma plans to donate RFID scanners to law-enforcement agencies. Since the pharmaceutical industry lacks a consensus on how best to deploy technological standards, GlaxoSmithKline is collaborating with wholesalers, pharmacies, and hospitals to determine how best to deploy RFID technology. Within the next year or so, GlaxoSmithKline plans to place RFID tags on one of its often counterfeited AIDS drugs.[25]

USD (AT&L) has issued a tri-period RFID implementation strategy for all products transported through DoD's supply chain (SC). Annual implementation is based on commodity-type. The implementation started in January 2005. DoD plans to include pharmaceuticals and medical supplies in January 2006. By January 2007 all products transported through DoD's SC will require RFID tagging.[26]

Although DoD is making this change within its SC, more needs to be done. According to Sanchez et al., a report recently released by the DoD Office of Inspector General indicated that medical treatment facilities (MTFs) were challenged in the area of efficiently managing inventory levels, stock rotation, and quick identification of expired and recalled pharmaceuticals. To counteract against this challenge, it is suggested that RFID tags be placed on each pharmaceutical bottle and smart shelves be installed. Smart shelves automatically read the tags and communicate current stock information to the contracted prime vendor. This type of automatic communication with the vendor will improve forecast for daily requirements and drastically reduce wasted dollars on expired and recalled pharmaceuticals.[27]

B. RETURN ON INVESTMENT (ROI)

Kevan reports that many are hoping that RFID will actually deliver an ROI. In his report, a management consulting firm, A.T. Kearney, Inc., warns RFID investors that the ROI will not be the same for each firm and may not be what they expect. It will

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[25] U.S. Food and Drug Administration, "Radio Frequency Identification Technology: Protecting the Drug Supply," March/April 2005, http://www.fda.gov/fdac/features/2005/205_rfid.html, June 2005.

[26] U.S. Under Secretary of Defense for Acquisition, Technology, and Logistics, Radio Frequency, 3-1.

[27] Sanchez et al., Medical Equipment, 57-8.

basically depend on the performance level of the company.[28] It is also believed that the industry type plays a big part in the ROI calculation as well.

Control Engineering reported that Automation Research Corporation (ARC) Advisory Group, a supply chain management consultant, suggested that most firms expect a payback period for investment in an RFID system to be more than two years. ARC completed a study on 24 firms that have already or plan to integrate RFID technology into its business systems. Of the 24 firms studied, only one firm reported that it expected to see an ROI within 12 months. ARC suggests that to mitigate cost risk involved in the technology investment, the following must take place:[29]

- Improved readability of tags
- Reduced tag cost
- RFID mandates by FDA, DoD, Wal-Mart and more major players

According to Mullen, early adopters predict a 15 percent reduction in labor cost resulting from reduced manual handling and more accurate data collection.[30] Control Engineering also reported that some experts suggested that both a partial RFID system working in conjunction with a barcode system can offer increased supply chain efficiency without investing in a full RFID infrastructure. Many experts agree with this claim.[31]

Sanchez et al. completed a sensitivity analysis on the data collected from their study site, NMCSD, a large MTF, and found that the capital investment for an RFID system implemented for tracing and tracking medical equipment would be less than $1.3 million. The payback period for this investment is estimated at one year.[32]

Although an RFID system's financial ROI may be uncertain and vary from firm to firm, investors are encouraged not to forget about the many non-financial ROI gained

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[28] Tom Kevan, "Calculating RFID's Benefits," Frontline, (2004): par 1-3, http://www.frontlinetoday.com/frontline/article/articleDetail.jsp?id=82290&&pageID=1, June 2005.

[29] Control Engineering, "RFID: ROI More Than 2 Years; High-speed Barcode Matching," (2004): par. 2-3, http://www.manufacturing.net/ctl/article/CA477152, June 2005.

[30] Dan Mullen, "Benefiting from RFID," Looksmart's Find Articles, (2004): par 39, http://www.findarticles.com/p/articles/mi_m0EEH/is_11_28/ai_n8585278, June 2005.

[31] Control Engineering, "RFID."

[32] Sanchez et al., Medical Equipment, 63.

through RFID technology such as increased efficiency, better asset visibility, less manual labor, increased patient safety, and increased patient satisfaction.

C. CHALLENGES

Although RFID technology has a number of advantages, certain challenges must be addressed. A few of the recognized challenges are cost, security, health, and readability. These are discussed below.

1. Cost

Blubaugh reports that the cost of integrating an RFID system into a firm's current business system can be very expensive when compared to a barcode system. For example, an RFID tag's average cost is .50 cents, but the current cost of a barcode is less than $.01.[33] The cost of an RFID reader can range from $100 to $3000.[34] Today, a bar code reader can cost less than $100. For an organization such as a hospital or a retailer with a huge warehouse, we can clearly see that the infrastructure cost of implementing RFID technology will far exceed that of the bar code system.

Collins reported that according to AMR Research (an independent analyst for the supply chain and technology industries based in Boston, Massachusetts), it will cost an average consumer product goods (CPG) manufacturer $13 million to $23 million to distribute 50 million RFID-tagged cases to Wal-Mart. Of the given cost, $5 million to $10 million will be consumed for RFID tags and readers. The other $8 million to $13 million will be spent on systems integration, changes to supply chain applications, and analytical software to efficiently use the huge volume of data captured through RFID technology.[35] In the given example, RFID system integration, etc., makes up 62 percent of the total cost. Some believe that the system integration cost can be as much as 75 percent of the total implementation cost. "Stand alone" systems, such as the pilot study

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[33] Marc Blubaugh, "RFID Becoming Standard Whether Firms Like It or Not," Columbus Business First, (2004): par 10, http://www.bizjournals.com/columbus/stories/2004/10/04/focus8.html, June 2005.

[34] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 5.

[35] Jonathan Collins, "The Cost of Wal-Mart's RFID Edict," RFID Journal., http://www.rfidjournal.com/article/articleview/572/1/26/, November 2005.

completed at NMCSD for tracking medical equipment usually have less system integration cost, a shorter payback period, and a higher ROI.

Wal-Mart has 75,000 suppliers and DoD has 60,000 suppliers. With mandates forcing their respective suppliers to become RFID compliant, they expect to lead change in supply chain management and drive down the cost of RFID technology so that it is quickly adopted by more firms.

2. Security

According to Blubaugh and many others, security is an issue when it comes to the possibility of a firm's business information line being tapped into by a competitor through the use of RFID technology.[36] Also, many privacy advocacy groups argue that anyone with an RFID reader can access personal data of a patient. Sanchez et al. agree that the advocacy groups have a valid concern. Sanchez et al. and many others argue that like any new technology, there will always be a give-and-take between legitimate uses that benefit consumers and potential abuses. They also stated that RFID manufacturers are currently looking at possible advancements that will enhance security and eliminate these concerns. Sanchez et al. continue to stress that RFID utilization offers MTFs the ability to quickly and accurately collect needed patient data and improve processes that increases patient safety and patient satisfaction.[37]

3. Health

According to Thillairajah et al., not only are consumers concerned with possible violation of privacy, they are also concerned with the health effects of radio waves. The radio frequency freely travels through the air waves not requiring a line of sight to communicate. Radio frequency waves are everywhere, not confined to a particular space. Consumer advocacy groups have expressed concerns of not having a choice of knowing when and where the technology is actually being used. Consumers ask, "What are the

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[36] Marc Blubaugh, "RFID Becoming Standard Whether Firms Like It or Not," Columbus Business First, (2004): par 10, http://www.bizjournals.com/columbus/stories/2004/10/04/focus8.html, June 2005.

[37] Sanchez et al., Medical Equipment, 52-3.

health impacts of these waves being everywhere? Is this technology conducive for living in a safe environment?"[38]

GAO has expressed its concerns as well. In regards to health, it stresses the importance of not forget about reverse logistics. Reverse logistics include proper disposal, reuse, and recycling of the RFID tag. Due to the fact that some of the tags contain materials that could become a health hazard such as silicon, copper, aluminum, and nickel, proper disposal must be enforced. The Environmental Protection Agency stresses the importance of ensuring that an effective reverse logistics program is in place to ensure that these types of materials do not dissolve into the environment and later cause health problems.[39]

4. Readability

Mullen reports that current tag readability is not 100 percent. Reports show that most performance tests are below 90 percent. Mullen also reports that Bill Allen, Texas Instruments, says that it is impossible to reach 100 percent readability rate in the beginning. It takes time and process refinement to reach the 100 percent read level.[40] Blubaugh states that the interference of metal can affect the performance of the tag. The performance of tags located near water is also degraded.[41] In Mullen's report, John Thorn stresses that design and location placement of the tag must be carefully considered to minimize metal and water influences so that the read rate is maximized.[42]

D. CONCLUSION

RFID technology offers a host of benefits. DoD has embraced RFID technology in its SCM process to improve visibility, inventory management, automation of manual processes that increases productivity, near to actual real-time data, better control of

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[38] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 7.

[39] U.S. Government Accountability Office, Information Security, 26.

[40] Mullen, "Benefiting from RFID," 3.

[41] Blubaugh, "RFID Becoming," 1.

[42] Mullen, "Benefiting from RFID," 3.

products nearing expiration, fewer stock outs, less shrinkage, and easy identification of recalled products. All of the applications mentioned in this literature review focused on applications that have the potential to specifically enhance the quality of healthcare service provided to active duty, retired, and reserve service members and their families while reducing overall cost and increasing efficiency.

According to Paul G. Kaminski, former Under Secretary of Defense for Acquisition, Technology, and Logistics, "Every logistics dollar expended on outdated systems, inefficient or excess capability and unneeded inventory is a dollar not available to build, modernize or maintain war fighting capability."[43] Providing healthcare services to the service members and their families is a great calling. As time progresses, technology is advancing to offer more and more ways to answer this calling more efficiently. RFID technology might possibly help solve some of the most pressing problems within DoD's healthcare system. Indeed, RFID technology is a best practice solution in providing the right product, at the right time, at the right place, and at the right price every time.

[43] U.S. Department of Defense, Lean Logistics: Better, Faster, Cheaper, 1996 (Washington, DC: GPO, 1996), 99, http://www.defenselink.mil/speeches/1996/s19961024-kaminski.html, September 2005.

III. WHY DO FIRMS IMITATE EACH OTHER?

> Radio frequency identification (RFID) has true potential as a disruptive technology, with huge benefits for those who seize the opportunity early. RFID and electronic product tagging (EPC) have the potential to force radical change in a number of industries. These technologies uniquely identify every product in a value chain. Benefits include streamlining the supply chain by increasing visibility and enabling greater collaboration. RFID/EPC will enable many of the benefits retailers are calling for, and will ultimately provide retailers with unparalleled data for future customer relationship management (CRM) programs.[44]

Business in today's dynamic economy requires organizations to constantly improve their existing products or offer new ones in order to stay competitive. The most common ways of doing this are through imitating other organizations' business processes, products, etc. or coming up with new ideas (innovation). While very distinct ideas, imitation and innovation have been very successful strategies when implemented correctly; both can lead to long-run competitive advantage and profit. [45]

Imitation is a common form of behavior that arises in a variety of business domains. Firms imitate each other in the introduction of new products and processes, in the adoption of managerial methods and organizational forms, and in market entry and the timing of investment. For example, in the summer of 1988, Jack Welch the CEO of General Electric (GE) implemented an initiative called Best Practices to increase productivity. He issued a simple challenge to Michael Frazier of GE's Business Development department: How can we learn from other companies that are achieving higher productivity growth than GE? Frazier selected nine companies, including Ford, Hewlett Packard, Xerox and Toshiba from which to imitate best practices. In addition to

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[44] Accenture.com, http://www.accenture.com/xd/xd.asp?it=enweb&xd=industries\products\automotive\rfid_revolutionize.xml September 2005.

[45] Dan Debicella, Innovation and Imitation--Positional Determinants of Success and Failure: A Study of the Soft-Drink and Computer Industries (1995), par. 1, http://opim-sun.wharton.upenn.edu/~katseb/Downloads/innovation%20and%20imitation.html, October 2005.

specific tools and practices, Frazier's team also identified several characteristics common to the successful companies.[46]

One of Welch's most repeated stories on how to leverage best practices described how managers from Canadian GE identified a small New Zealand appliance maker, Fisher & Paykel, which produced a broad range of products very efficiently in its small, low-volume plant. When Canadian GE implemented the flexible job-shop technique in their high-volume factory, the U.S. appliance industry became interested. More than 200 managers and employees from GE's Louisville plant went to Montreal to study the accomplishments, and soon cut their production cycle in half and reduced inventory costs by 20 percent. Not surprisingly, GE's Appliance Park in Louisville became a "must see" destination for many other businesses as diverse as locomotives and jet engines.[47]

GE quickly began to learn from (imitate) each other: productivity solutions from Lighting; "quick response" asset management from Appliances; transaction effectiveness from GE Capital; cost reduction techniques from Aircraft Engines; and global account management from Plastics.[48] Other clear and outstanding examples of internal "best practices" imitation at GE were: 1) in 1994, the real-time online diagnostic concepts which offered remote diagnostic and other services to medical equipment, aircraft engines, power systems and locomotives; by 1996, this $8 billion equipment services business was growing much faster than the underlying product business and by 1999 accounted for two-thirds of GE's revenues.[49] 2) When a 1995 company survey showed GE employees were dissatisfied with the quality of its processes and products, Welch imitated AlliedSignal's Six Sigma quality program. In 1996 he announced a goal of reaching Six Sigma quality levels company-wide by the year 2000, describing the

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[46] Christopher Bartlett and Meg Wozny, "GE's Two-Decade Transformation: Jack Welch's Leadership," President and Fellows of Harvard College, Case No. 9-399-150, 5.

[47] Ibid., 9.

[48] GE Annual Report, 1995.

[49] Christopher Bartlett and Meg Wozny, "GE's Two-Decade Transformation: Jack Welch's Leadership," President and Fellows of Harvard College, Case No. 9-399-150, 11.

program as "the biggest opportunity for growth, increased profitability, and individual employee satisfaction in the history of our company."[50]

Welch describes GE as the largest petri dish of businesses in the world. With roughly 350 business segments, he wanted GE leaders to view them as 350 laboratories whose ideas are there to be shared, learned and spread as quickly as possible throughout the entire organization, in effect, creating a company-wide internal consulting mini-industry or as he put it " globalizing the intellect of the company."[51] (See Figure 1 for the simple two-step imitation process). Despite its frequent occurrence, imitation can have radically different causes and implications. Firms may imitate to avoid falling behind their rivals, or because they believe that others' actions convey information.

Figure 1. Simple Two-Step Imitation Process

A. SO WHY NOT INNOVATE MORE?

> For every thousand flowers that bloom, a million weeds surface. Best to cultivate from the greats. – Chairman Mao[52]

Nicholas G. Carr postulates in his article "*Mastering Imitation*" that in a free market, innovation underpins competitive advantage, which in turn undergirds

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[50] Christopher Bartlett and Meg Wozny, "GE's Two-Decade Transformation: Jack Welch's Leadership," President and Fellows of Harvard College, Case No. 9-399-150, 12.

[51] Ibid., 13.

[52] Nicholas G. Carr, "Mastering Imitation," Strategy+Business, Fall 2004 http://www.strategy-business.com/press/article/04301?pg=all, September 2005.

profitability. Being indistinguishable from everyone else means operating with a micro thin profit margin, if not outright losses. So why not try to innovate everywhere — to let, as Chairman Mao famously put it, a thousand flowers bloom?[53]

Well because for every thousand flowers, you get a million weeds. Innovation is by its very nature is expensive. It demands experimentation, speculative investment, and failure, all of which entail high costs and risks. Indeed, it is innovation's intrinsic uncertainty that gives it its value. High risks and costs form the barriers to competition that give successful innovators their edge. If innovation were a sure thing, everyone would do it equally well, and its strategic value would be minimized. It would become just another cost of doing business.[54]

The most successful companies know when to take a chance on innovation, but they also know when to take the far safer, albeit less glamorous, route of imitation. Although imitation is often viewed as innovation's homely sibling, it is every bit as central to business success. Indeed, it makes innovation economically feasible.[55]

So the critical first question for any would-be innovator should not be *How?* But *Where?* Deciding where to innovate — and where not to — is fundamentally a strategic exercise, requiring a clear understanding of a company's existing and potential sources of competitive advantage. If corporate innovation involves a deliberate attempt to create a new product or practice with commercial value, then the target should be one in which a company differentiates itself from its competitors. A meaningful point of differentiation is one that, to paraphrase Michael Porter, translates into either lower-cost operations or higher-value products, the two linchpins of outstanding profitability.[56] The important thing is to be able to sustain the differentiation long enough to at least offset the up-front

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[53] Nicholas G. Carr, "Mastering Imitation," Strategy+Business, Fall 2004, http://www.strategy-business.com/press/article/04301?pg=all, September 2005.

[54] Ibid.

[55] Ibid.

[56] M. E. Porter, "The Structure within Industries and Companies' Performance," Review of Economics and Statistics, 1979, 61: 214-227.

costs and risks of innovation.[57] A good example of this would be Intel's approach in the late 1980's to competitors it regarded as cloning its products. Intel decided to enforce its intellectual property rights through patent infringements lawsuits and related legal battles. By the early 1990's, Intel faced credible threats from a number of rivals including AMD, Texas Instruments and Cyrix who could produce microprocessors compatible with Microsoft's MS-DOS operating system. To counter-attack these competitors, Intel's strategy for its fifth (Pentium) and sixth (Pentium Pro) generation microprocessors was to achieve an overwhelming advantage in performance over competitive offerings. Albert Yu, who along with Paul Otellini, was responsible for Intel's microprocessor development efforts, explained that

Volume is key to everything. A leading edge design will take 50 to 100 top engineers two to three years to develop. Total development costs will probably range from $50 to $100 million. In addition to that, the processor must make use of the latest manufacturing technology to be cost effective. A leading fab [semiconductor plant] can require $700 to $800 million in capital investment. You have to sell a lot of processors to recoup these costs.[58]

The proper focus of innovation will vary greatly from company to company, but at a high level, successful businesses can be divided into two camps: process innovators and product innovators. Process innovators distinguish themselves by being more efficient in how they work; they produce fairly standardized products at a lower cost than competitors do, enabling them to earn relatively high profits at prevailing market prices (or drive competitors out of business through ruthless discounting). Process innovators tend to be the largest of all companies, dominating big, mature markets. Product innovators, on the other hand, make their mark by offering customers particularly attractive goods or services — those that offer superior functionality, more fashionable designs, or simply more enticing brand names or packaging. Their supernormal

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[57] Nicholas G. Carr, "Mastering Imitation," Strategy+Business, Fall 2004, http://www.strategy-business.com/press/article/04301?pg=all, September 2005.

[58] Dan Steere, "Intel Corporation (D): Microprocessors at the Crossroads," Graduate School of Business, Stanford University, Case BP-256D, 5.

profitability derives from the premium prices they can charge. Product innovators tend to pioneer new markets or to hold lucrative niches in older industries.[59]

In the personal computer market, Dell stands as a classic process innovator. Its products are essentially commodities that meet the needs of its customers. However, through the relentless fine-tuning of its supply chain, assembly, and distribution operations, Dell has gained a wide cost advantage over its rivals that has made it the fastest-growing, most profitable company in its industry. Apple, on the other hand, is the model of an effective product innovator. It has carved out a profitable niche in a cutthroat business by offering distinctive and stylish products for which a sizable set of customers are willing to pay more.[60]

Especially noteworthy about Dell and Apple, is the discipline they bring to innovation. They innovate where creativity will support their core advantages, and they imitate elsewhere. You could argue, in fact, that to be a successful product innovator you need to be an adept process imitator, and to be a winning process innovator you need to be a good product imitator.[61]

Dell, for instance, is skilled at quickly copying products and product features, which has enabled it to apply its superior process skills to a series of new markets, from servers to storage drives to switches. In some cases, it simply contracts with existing suppliers to provide it with commodity products to push through its distribution system. In challenging Hewlett-Packard in the lucrative market for printers, Dell is buying its products from Lexmark and rebranding them as its own. Dell does the same thing with monitors it purchases from Sony. It thus avoids high research and development expenditures, further reinforcing its cost advantage.[62]

As for Apple, its resurgence since the late 1990s has been as attributable to emulating processes as to developing breakthrough products like the iMac and iBook.

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[59] Nicholas G. Carr, Mastering Imitation, strategy+business, Fall 2004, http://www.strategy-business.com/press/article/04301?pg=all, October 2005.

[60] Ibid.

[61] Ibid.

[62] Ibid.

Soon after Steve Jobs returned as CEO in 1996, he hired an operations ace, IBM and Compaq veteran Timothy Cook, to retool the company's rusty supply chain. By copying the best practices pioneered by companies like Dell, Mr. Cook dramatically reduced Apple's in-channel inventory, and the savings in working capital provided an immediate boost to profitability. On the distribution end, Apple has successfully copied efficient direct-to-customer channels such as online sales and dedicated stores.[63]

Just to wrap up, we have clearly distinguished between products and processes and between innovation and imitation. The lesson is clear: innovate in those places where you can differentiate yourself from the competition. Where differentiation promises to be elusive or fleeting, imitate.[64]

B. WHAT IS IMITATION?

It is said that imitation is the sincerest form of flattery, however when it comes to firms imitating each other the outcome can vary. Lieberman and Asaba, in their paper *Why Do Firms Imitate Each Other*?, organized theories of business imitation into two broad categories: 1) *information-based theories*, where firms follow others that are perceived (sometimes erroneously) as having superior information, and 2) *rivalry-based theories*, where firms imitate others to maintain competitive parity or limit rivalry. In the next section of this chapter we review their description of information-based theory.

C. INFORMATION-BASED THEORIES OF IMITATION

Information-based theories of imitation have been proposed by various fields of research. These theories apply in environments where firms cannot assess connections between actions and outcomes with great confidence. In such environments of uncertainty and ambiguity, firms look for information about the actions of others. Such information, while highly imperfect, can have a strong influence on managerial

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[63] Nicholas G. Carr, "Mastering Imitation," Strategy+Business, Fall 2004, http://www.strategy-business.com/press/article/04301?pg=all, September 2005.

[64] Ibid.

perceptions and beliefs.[65] This may include actions in other parts of their own organizations. For example after the terrorists attacks on September 11, 2001, the U.S. Secretary of Defense wanted to be able to deploy light, lean forces rapidly to go after the terrorists. He was very unhappy with the army's inability to do this, and as a result, the army is now transforming itself (i.e. imitating) to be lighter and leaner like its sister services.

In economic theories of imitation, the information component has been looked at extensively. The most prominent economic theory of herd behavior is called information cascades or social learning.[66] Bikhchandani et al. state information cascades occur "when it is optimal for an individual, having observed the actions of those ahead of him, to follow the behavior of the preceding individual without regard to his own information."[67] In other words, if a person (or company) has some private information and acts on it, his action influences the behavior of others (followers), especially if that person/company is held in high regard. The model formalizes a process of Bayesian learning. ***As this revealed information becomes well-known, it may be rational for followers to ignore their own prior information and mimic the decisions of others.*** A typical example is a diner at a restaurant who observes that his fellow diners are all ordering the same item from the menu. He may have intended to order a different item, something with which he was familiar, but is swayed by his observation of the other diners, which suggests (perhaps erroneously) that the trend may offer a more satisfying culinary experience (i.e. greater return on his investment). Thus, agents may choose to

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[65] M. B. Lieberman and S. Asaba, Why Do Firms Imitate Each Other?, Jul 2004, http://www.anderson.ucla.edu/faculty/marvin.lieberman/publications/ImitationSurveyPaperFinal.pdf, September 2005.

[66] A.V. Banerjee, "A Simple Model of Herd Behavior," Quarterly Journal of Economics, 107: 797-817.

S. Bikhchandani, et.al., "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," Journal of Political Economy, 100: 992-1026.

S. Bikhchandani, et al., "Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades," Journal of Economic Perspectives, 12: 151-170.

[67] S. Bikhchandani, et al., "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," Journal of Political Economy, 100: 992-1026.

go against their initial information as they draw inferences from the observed behavior of others.[68]

Similarly, as entrepreneurs and investors are persuaded by such observations, the wave of entrants grows. However, as Bikhchandani et al. point out, such processes are inherently fragile and subject to reversal. [69] Just as a certain amount of positive actions or hype is needed to start the cascade upward, a sufficient number of negative signals will reverse the process. This may characterize the current state of RFID implementation. A recent article in SupplyChainDigest.com entitled "The Slow Leak in the EPC Balloon," suggested there had been a noticeable slow down in the RFID/EPC mania that has gripped the industry for much of the past year. The article states the winds seemed to be pointing to a slow down in activity: Wal-Mart taking a bit of a breather; most other retailers taking the slow and steady approach; consumer packaged goods(CPG) companies pushing back based on high cost and lack of return; consultants and RFID vendors complaining of a serious lack of business.[70] Are these signs similar to the collapse of the Internet bubble in the mid-2000, as pessimistic assessments began to appear and grew rapidly? Internet stock prices fell to a fraction of their previous levels and entry came to a virtual halt. The dramatic rise and fall took place within the span of just two or three years, much faster than the rate at which concrete data emerged on the long-term prospects for Internet commerce.

In driving such a bandwagon, the actions of some individuals or firms may be weighted more strongly than others. If some are perceived as likely to have superior information, they can become "fashion leaders."[71] For example, when large firms such as Wal-Mart and Tesco decided to implement RFID in their supply chain management

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[68] M. B. Lieberman and S. Asaba, Why Do Firms Imitate Each Other?, Jul 2004, http://www.anderson.ucla.edu/faculty/marvin.lieberman/publications/ImitationSurveyPaperFinal.pdf, September 2005.

[69] S. Bikhchandani, et al., "A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades," Journal of Political Economy, 100: 992-1026.

[70] D. Gilmore, "Slow Leak in the EPC Balloon – Readers Respond," Supply Chain Digest, Jul 17, 2005, http://www.scdigest.com/assets/News/05-07-21.htm, July 2005.

[71] S. Bikhchandani, et al., "Learning from the Behavior of Others: Conformity, Fads, and Informational Cascades," Journal of Economic Perspectives, 12: 151-170.

processes, smaller firms followed, as they believed the former to be better informed. Similarly, firms that are consistently successful are more likely to have their actions imitated. In the case of RFID implementation, the entry of the Department of Defense, Target and other prominent organizations helped legitimize the efforts of other firms to quickly investigate the potential benefits of RFID technology.

A second economic theory of herd behavior is based upon the idea that managers ignore their own private information and imitate the decisions of others in an effort to avoid a negative reputation. This highlights what is known as "agency" problems i.e. that managers (agents) do not necessarily do what's right for the principal(organization). Instead, they do what's right for them. These issues have been widely studied in politics as politicians serve two masters, their constituents and their political affiliations. By voting along party lines, they may alienate their constituents and thus possible stand a chance of not being reelected. At the same time, voting against their party could lead to severe repercussions in terms of political support and more importantly, funding. A classic catch-22 dilemma. In order to avoid a negative reputation, politicians walk a fine line and the ones that are new to the game emulate those that have been successful. Similarly, in order to be evaluated as a superior type, managers ignore their own information and imitate others that are held in high regard.[72] Such imitation serves to enhance the managers' status or reputation.

This theory may help to explain the herd behavior of analysts and institutional investors in driving the Internet bubble upward. Financial actors are evaluated on their performance relative to peers; those who deviate too far from the mainstream and ultimately fail, will likely suffer a fatal loss of reputation. We can see examples of that occurring right now in the U.S. housing and real estate market. During the rise of the bubble it was widely believed that the leading analysts had superior signals, which led them to be optimistic about the future of the housing and real estate market. Those who did not follow were often shunned for their failure to understand the housing market and that investing in real estate is a no-lose situation. Under these circumstances, less-

[72] T. I. Palley, "Safety in Numbers: A Model of Managerial Herd Behavior," Journal of Economic Behavior and Organization, 28: 443-450.

informed analysts and investors often chose to join with the crowd, pushing housing and real estate prices even higher. This example shows how the second economic theory of herd behavior can complement the first: information cascades likely contributed to the emergence of the trend, which was further sustained by reputation-based signaling on the part of analysts and investors.[73]

These information-based theories describe processes where organizations learn by drawing inferences from the behavior of others. Other forms of learning occur in as more detailed information emerges from the experience of early movers, and as organizations assess their own experience.[74] Whether firms choose one mode of learning over another depends upon the resources and time they have before making a decision. Experiential learning is more costly and time-consuming than imitation. When firms have sufficient time and resources to explore their environment, experiential learning will be the optimal choice. However, in highly uncertain environments where quick action is necessary, imitating others becomes the most cost-efficient option. Such an option appeals most to those with little prior information on which to base a decision; firms that are more knowledgeable may rely on what they know internally.[75]

D. THE CATCH

Bikchandani et al. make the point that information cascades fail to provide "deep" learning; after the start of the cascade the actions of followers provide no additional information, since they are simply responding to the information revealed by the initial actors. Based on this shallowness of beliefs, only a limited amount of independent learning is necessary to overturn the cascade if the imitated behavior proves futile.

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[73] M. B. Lieberman and S. Asaba, Why Do Firms Imitate Each Other?, Jul 2004, http://www.anderson.ucla.edu/faculty/marvin.lieberman/publications/ImitationSurveyPaperFinal.pdf, September 2005.

[74] J. A. C Baum, et al., Making the Next Move: How Experiential and Vicarious Learning Shape the Locations of Chains' Acquisitions, Administrative Science Quarterly, 2000,45:766-801.

P. R. Haunschild & A. S. Miner, "Modes of Interorganizational Imitations: The Effects of Outcome Salience and Uncertainty," Administrative Science Quarterly, 1997, 42(3): 472-500.

Subsequently, a new cascade may arise once a sufficient number of firms discover a superior alternative. For example, the continual progression of management "fads" (e.g., "total quality management," "re-engineering," "employee empowerment," etc.) is proceeding roughly in this manner, as firms imitate organizations they believe to be better informed, but discover through experience, the limits of the new managerial system. In many other domains where imitation occurs, uncertainty is resolved more quickly or completely. This makes reversals more likely and may prevent the imitation entirely if firms wait to learn from the experience of early movers.[76]

E. CONCLUSION

We have discussed the difference between innovation and imitation and information-based theories of imitation. We saw how GE utilizes imitation extensively, both internally and externally, to improve its operations, processes, increase market share and as a tool to globalize the intellect of the company. Innovation on the other hand was shown to be expensive and risky. Those companies that choose to innovate must do so carefully, in order to differentiate themselves from others.

In highly uncertain environments, such as the RFID industry, we learned that information-based imitation theories seem to thrive as firms will ignore their own information to imitate those they believe to have superior information. This of course can have both positive and negative outcomes. Some of the potential benefits of imitation are: it can speed the adoption of new innovations; increase competitive pressures which leads firms to improve their products (better value for the consumer); and promote operational efficiencies within organizations. On the negative side, imitation can lead to destructive competition, overinvestment (e.g. the Internet, housing and real estate markets), reduced variety of products and some risk, if the information turns out to be erroneous.

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[75] M. B. Lieberman and S. Asaba, Why Do Firms Imitate Each Other?, Jul 2004, http://www.anderson.ucla.edu/faculty/marvin.lieberman/publications/ImitationSurveyPaperFinal.pdf, September 2005.

[76] M. B. Lieberman and S. Asaba, Why Do Firms Imitate Each Other?, Jul 2004, http://www.anderson.ucla.edu/faculty/marvin.lieberman/publications/ImitationSurveyPaperFinal.pdf, September 2005.

In the next chapter, we discuss our methodology for choosing four organizations, two from the wholesale/distribution industry and two from the hospital sector, as they jump on the “bandwagon” to implement RFID technology into their business processes.

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IV. WHO AND WHY WE CHOSE THEM?

Selecting which firms to look at for this project was a daunting task. Not only because RFID technology is relatively new, but also because not many firms have jumped on the "bandwagon" as quickly as we would have thought. Instead most have taken a "wait and see" approach to determine whether the benefits, return on investment, and all the other positive things they have read or heard about in the press are really true.

A. WHO WE CHOSE?

In the interest of time and resources we looked at four organizations – two from the pharmaceutical wholesale/distributor industry, McKesson Corporation and H. D. Smith Wholesale Drug Company and two hospitals, Massachusetts General and Jacobi Medical Center. We chose them based on the criteria below:

Fortune Magazine recently ranked McKesson Corp. number 16 with $69.5 billion revenue for 2004. For fiscal year 2005, McKesson has generated $80.5 billion in revenue, a 16 percent growth from 2004, which was 90 percent driven by its Pharmaceutical Solutions segment. McKesson is the provider of supply, information, and care management products and services and is headquartered in San Francisco, CA.

McKesson has been a strong advocate of FDA's RFID technology initiative to establish an electronic pedigree of pharmaceuticals. It is one of the few companies that participated in an industry-wide test called JumpStart. The multi-disciplined team consisted of manufacturers, distributors, and retailers. The lead for the initiative is Accenture, an organization that specializes in consulting, technology, and outsourcing solutions packages.[77]

H.D. Smith Wholesale Drug Company, the seventh largest pharmaceuticals distributor in the U.S., made the leap into aggressively implementing RFID technology in 2004. They attach one-inch-square tags embedded with electromagnetic microchips

[77] Medical Devices & Surgical Technology Week, "Medical Device; Healthcare services support FDA policy on radio frequency identification," December 26, 2004, 250.

carrying an electronic product code (EPC) to all their prescription narcotic shipments before they are sent to their final destination. Using RFID technology they are able to identify and track every single package separately. They have made the huge investment necessary to provide this service to their customers and feel the technology is well worth the investment in terms of the benefits and savings to be realized.[78]

Massachusetts General Hospital (MGH) founded in 1811, is the third oldest general hospital in the United States, and the oldest and largest in New England. The 893-bed world-renowned medical center offers sophisticated diagnostic and therapeutic care in virtually every specialty and subspecialty of medicine and surgery. MGH conducts the largest hospital-based research program in the United States, with an annual research budget of more than $450 million. It is the oldest and largest teaching hospital of Harvard Medical School, and nearly all of the hospital's active staff physicians are on the Harvard Medical School faculty.

The implementation of RFID technology at MGH is still in its experimental stages. As part of its Operating Room of the Future (ORF) concept, RFID has been tested with patient and staff tracking, as well as testing various types of RFID-enabled equipment, such as smart cabinets, used by anesthesiologists to track and inventory drug usage in the operating room(OR), and medical equipment.

Jacobi Medical Center, the largest public hospital in Bronx, NY is keeping track of patient information using RFID-enabled “smart wristbands” that can be scanned through clothing or blankets. The technology makes it easier for the medical staff to retrieve information about individual patients, and it does so without health care professionals having to disturb patients even if they are sleeping and the room is dark. The North Bronx Healthcare Network (NBHN) implemented the technology with the help of Siemens Business Services. Jacobi Medical Center, a 500+ bed facility, provides quality health care for some 1.2 million Bronx and New York area residents.

[78] Caroline Van Hasselt, “When Bar Codes Aren’t Good Enough,” Treasury & Risk Management, Dec/Jan 2005, 17.

B. WHY WE CHOSE THEM?

The criteria we chose to distinguish the market leaders in RFID implementation in their respective industry are as follows:

- DIRECT REFERENCE BY industry analysts, journalists, consultants that indicate these firms are RFID leaders their industries.
- DATA INDICATING THESE ORGANIZATIONS ARE INDUSTRY LEADERS -- Financial indicators, publicly available data that show they are market share/profit leaders in their industries. Fortune's "Most Admired/Top 100 Best Firms to Work For"
- DATA INDICATING THAT OTHER FIRMS ARE WATCHING THEM CLOSELY -- Are other firms in the same industry watching their implementation processes and trying to imitate? For example, when Wal-Mart became the largest retailer in the world, everyone in that industry wanted to know the secrets of their success. As a result, the other large retailers are now taking a close look at their processes to see how they can imitate (and hopefully replicate) Wal-Mart's success.
- PRODUCT DIFFERENTIATION -- Are the firms implementing RFID differentiating themselves from their competitors by revolutionizing their business processes and better meeting the needs of their customers?
- INITIAL STAKEHOLDER FEEDBACK THAT THINGS ARE GOING WELL (including customers) that RFID implementations are a success -- Are the stakeholders (internal and external) satisfied with the initial results from RFID implementation? Could be financial, customer service (i.e. on shelf availability), business process improvements, etc.
- KNOWLEDGE MANAGEMENT – How a company's established systems, structures and values support its capacity to acquire, share, and use knowledge in ways that improve its survival and success. Its intellectual capital, the sum of everything an organization knows that gives it competitive advantage – including its human capital, structural capital, and relationship capital.

By using the above criteria and going through a triangulation process, we used multiple data points (criteria) that together, supported the selection of these particular organizations.

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V. CASE STUDY – MASSACHUSETTS GENERAL HOSPITAL

A. PROFILE

The market for healthcare RFID solutions is ripe with opportunity, not only in terms of patient safety, but also in terms of unmet demand for broader applications of the technology within healthcare organizations. Integrated medication management, automated identification, asset management, and inventory control are just a few industry opportunities that are poised for growth. Very few U.S. hospitals currently have deployed RFID patient safety solutions, but the clinical utility, cost advantages, and collateral benefits of RFID will spur growth of these technology solutions. Industry-wide adoption is likely to occur within the next four to six years.

Founded in 1811, the Massachusetts General Hospital (MGH) is the third oldest general hospital in the United States and the oldest and largest in New England. The 893-bed world-renowned medical center offers sophisticated diagnostic and therapeutic care in virtually every specialty and subspecialty of medicine and surgery.

Each year MGH admits approximately 44,000 inpatients and handles almost 1.5 million visits in its extensive outpatient programs at the main campus and at its four health centers, in the Back Bay, Charlestown, Chelsea and Revere. Its emergency services handle nearly 75,000 visits annually. Each year the surgical staff performs more than 32,000 operations, and the MGH Vincent Obstetrics Service delivers more than 3,600 babies.[79]

MGH conducts the largest hospital-based research program in the United States, with an annual research budget of more than $450 million. It is the oldest and largest teaching hospital of Harvard Medical School, and nearly all of the hospital's active staff physicians are on the Harvard Medical School faculty.

MGH is the largest non-government employer in the city of Boston, with more than 19,500 employees, including a nursing staff of 2,900. In addition, its 3,600-member

[79] Massachusetts General Hospital., Overview, http://www.massgeneral.org/news/for_reporters/overview.htm, October 2005.

medical staff includes physicians, dentists, psychologists, podiatrists, residents and fellows.

In March 1994, the MGH joined with Brigham and Women's Hospital to form Partners HealthCare System, Inc., an affiliation established to create an integrated health care delivery system providing excellent, cost-effective care while maintaining the hospital's historic dedication to teaching and research. In addition to the founding institutions, Partners HealthCare System now includes North Shore Medical Center, Newton-Wellesley Hospital and Faulkner Hospital.

Partners' physician network, Partners Community HealthCare, Inc., currently includes more than 1,000 primary care physicians and 3,500 specialists. Partners also includes home health agencies, McLean Hospital, a psychiatric facility in Belmont, Mass., and Spaulding Rehabilitation Hospital in Boston. Partners also is involved in a collaborative program for adult oncology with Dana-Farber Cancer Institute.

In July 2004 MGH was named one of the country's best hospitals by U.S. News and World Report for the fifteenth year, ranking third nationwide.[80]

B. MGH: A TRADITION OF ALWAYS BEING ON THE CUTTING EDGE OF TECHNOLOGY

MGH has an outstanding reputation and tradition of pioneering new clinical procedures and technologies all in the name of providing world-class patient healthcare. Some major MGH milestones are:[81]

1846 The use of ether as an anesthetic. Surgery performed without pain for the first time.

1896 The first X ray image in the United States is made by an MGH physician just 30 days after the technique is discovered in Europe.

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[80] Massachusetts General Hospital., Overview, http://www.massgeneral.org/news/for_reporters/overview.htm, October 2005.

[81] Massachusetts General Hospital., Milestones, http://www.massgeneral.org/about/milestones.htm, October 2005.

1925 The first tumor clinic founded for the study of cancer.

1945 Researcher at the Vincent Memorial Hospital, the gynecology service of the MGH, perfects use of Pap smear to detect cervical cancer.

1962 MGH surgeons accomplish the first successful reattachment of a severed human limb.

1964 Research completed at the MGH makes practical for the first time the long-term storage of human blood.

1979 MGH radiologists pioneer use of MRI (magnetic resonance imaging) to diagnose illness and injury.

1980s MGH researchers make numerous key discoveries regarding AIDS and infection with HIV, including showing that the virus can infect the brain and nervous system and detection of HIV in female genital secretions.

1981 MGH, MIT and Shriners Burns Institute researchers create the first artificial skin made from living cells.

1987 MGH researchers contribute to discovery of first gene associated with inherited, early-onset Alzheimer's disease.

1990s Researchers at the MGH are among the first to investigate combination therapy treatment for AIDS, using "cocktails" of several anti-HIV drugs to suppress viral reproduction. The approach results in dramatic improvement in the health of people with AIDS.

1991 Researchers at the MGH NMR (nuclear magnetic resonance) Center are the first to develop high-speed MRI scanning. A year later the technique is used for the first time to view brain metabolism without use of contrast agents or tracers.

1993 MGH researchers discover genes responsible for Huntington's disease, ALS (Lou Gehrig's disease) and neurofibromatosis Type 2 (NF2). MGH surgeons are the first to use computerized brain images made by fusing information from both MRI and PET scans as a "road map" to guide an operation. MGH surgeons perform the first heart-liver transplant in New England.

1995 MGH surgeons perform the first double-lobe, living-related lung transplant in New England.

2000 Surgeons from the MGH transplant team are the first to perform split-liver transplant procedures in the Northeastern U.S. The procedure, in which the liver from a single donor is divided between two recipients – usually and adult and a child – is another way to deal with the continuing shortage of donor organs.

2001 The first International Medical and Surgical Response Team (IMSuRT) of the National Medical Disaster System, based at MGH, sees its first action in response to the September 11 tragedy in New York City. The MGH IMSuRT and other Boston disaster teams treat more than 5,000 workers during the first 11 days after the disaster.

2003 An MGH physician and a former colleague receive the Inventor of the Year Award for their invention of a system to safely deliver inhaled nitric oxide gas to treat a number of dangerous lung conditions.

2004 An underlying principle of mammalian reproductive biology is apparently overturned when MGH researchers find that female mice retain the ability to make new egg cells well into adulthood.

The above list is just some of the major new clinical procedures and technologies MGH has to its credit in its almost two centuries of unparalleled existence and they are not resting on their laurels. MGH is now looking at ways to revolutionize and define the characteristics of the ideal operating room (OR) for minimally invasive surgery. Their Operating Room of the Future (ORF) Implementation Project is designed for optimal support of advanced minimally invasive surgery, to allow technology assessment and development in a live, patient-care environment, and as a test environment to explore redesigning peri-operative patient movement and work processes.[82]

[82] Sandberg, Warren S., Daily, Bethany, Egan, Marie, Stahl, James E. Goldman, Julian M.,Wiklund, Richard A., Rattner, David, "Deliberate Perioperative Systems Design Improves Operating Room Throughput"Anesthesiology 2005, 103: 406.

C. RFID IMPLEMENTATION

The implementation of RFID technology at MGH is still in its experimental stages. As part of its ORF concept, RFID has been tested with patient and staff tracking, as well as testing various types of RFID-enabled equipment, such as smart cabinets, used by anesthesiologists to track and inventory drug usage in the OR, and medical equipment.

According to Dr. Warren Sandberg, Associate Professor of Anesthesiology at Harvard Medical School and Assistant Head of Anesthesiology at MGH, the hospital started its RFID pilot study in the summer of 2004 with patient tracking. MGH began the pilot study to learn more about the technology and to prove whether the technology could be beneficial. Dr. Sandberg, along with Steve Spring, Finance Manager, Operating Room and Critical Care departments are the lead agents for conducting RFID pilot studies at MGH.[83]

The hospital's top leadership has also been involved from the beginning, and part of MGH's strong organizational culture encourages the entrepreneurial spirit to flourish, allowing monitored creativity. When asked about using consultants to help them implement this new technology, Spring replied "We MGH feel we have the best and brightest employees working here who already know and understand the organization's culture. Why hire outsiders who would not be able to learn the organizational culture in a few weeks or months?"[84]

D. PATIENT TRACKING

In a paper, Dr. Sandberg et al. completed an experiment that demonstrated how current technology can automatically collect sufficient data to remotely monitor patient flow through a hospital, provide decision support based on predefined rules, and automatically notify stakeholders of errors. They provided data that show when procedures and processes to assure patient location based on human performance do not work as expected, patients were brought incrementally closer to a possible "wrong

[83] Kevin Gangadeen and Bernadette Houston, telephone interview with Dr. Warren Sandberg, September 6, 2005.

[84] Kevin Gangadeen and Bernadette Houston, interview with Steve Spring, September 27, 2005.

patient--wrong procedure" error. They developed a system for automated patient location monitoring and management. Real-time data from an active infrared/radio frequency identification tracking system provided patient location data that are robust and can be compared with an "expected process" model to automatically flag wrong-location events as soon as they occur. The system also generated messages that were automatically sent to process managers via the hospital paging system, thus creating an active alerting function to annunciate errors. They deployed the system to detect and annunciate "patient-in-wrong-OR" events. The system detected all "wrong OR" events, and all "wrong-OR" locations were correctly assigned within 0.50 ± 0.28 minutes (mean ± SD). This corresponded to the measured latency of the tracking system. All wrong-OR events were correctly annunciated via the paging function.[85]

E. IS RFID READY FOR PRIME TIME?

Dr. Sandberg and his colleagues, though very optimistic about the potential benefits of RFID, realize that there are many barriers to overcome. The technology is still immature and there are incompatibilities between equipment manufactured by different vendors. Universal standards still need to be put in place and readability degradation takes place when the chip/tag is made smaller.

Many of these limitations were unknown prior to the pilot study and were clearly revealed during pilot testing. According to Dr. Goldman, an assistant anesthetist "… in reality, its all about logistics, infrastructure, and systems. The entire supply chain must be onboard with standardization."[86]

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[85] Sandberg, Warren S., Häkkinen, Matti, Egan, Marie, Curran, Paige K., Fairbrother, Pamela, Choquette, Ken, Daily, Bethany, Sarkka, Jukka-Pekka, and Rattner, David, "Automatic Detection and notification of "Wrong Patient—Wrong Location" Errors in the Operating Room," Surgical Innovation 12, no. 3, (2005): 253.

[86] Kevin Gangadeen and Bernadette Houston, personal interview with Dr. Julian Goldman, September 27, 2005.

F. TRAINING

Some staff training has taken place, but not much. MGH is still in the experimental phase with RFID and is still testing patient and staff tracking. The beauty of this technology however, is that extensive training is unnecessary as the system works automatically once put in place.

G. WHY RFID?

The decision to test RFID was influenced internally and patient safety was the impetus behind its study. In 2001, the Institute of Medicine (IOM) of the National Academy of Sciences issued a landmark report titled "To Err is Human," that described the prevalence throughout the U.S. healthcare industry of widespread and often preventable medical errors. The IOM report stated that preventable medical errors cause up to 98,000 deaths and 770,000 adverse events in the U.S. each year. Since the IOM report was published, subsequent industry evidence has revealed that the problem not only persists, it appears to be getting worse. According to a 2001 report of the *Journal of the American Pharmaceutical Association*, medical errors translated into $177 billion in costs to the healthcare industry. In a more recent study conducted by HealthGrade, Inc. in 2003 that tracks medical quality, nearly 200,000 patient deaths each year are attributable to medical errors – that's twice the worst-case forecast in the IOM report. Finally, in 2002 the Managed Care Institute estimated that as many as 28 percent of all hospitalizations are attributed to drug-related morbidity-which translates to a cost of $50 billion per year.[87]

In each of these studies adverse drug events (ADEs) have been identified as a primary cause of preventable medical errors and one of the single greatest threats to patient safety. The term ADE describes drug administration errors that take a variety of forms including incorrect drug selection, incorrect dosage or frequency, and negative drug interactions. ADEs can result from the wrong medication being prescribed, the wrong medication being distributed by the pharmacy, or the wrong administration of the medication at the bedside. A report from the *Archives of Internal Medicine* found that almost one in five

[87] Zebra Technologies, "Patient Safety Applications of Bar Code and RFID Technologies," (White Paper, Zebra Technologies, 2005).

medication doses administered in hospitals is given in error. The two most common errors cited were medication dispensing at the wrong time (43 percent of incidents) and omitting a dose (30 percent). Seven percent of errors were found to be potentially harmful. In a nearly 900-bed facility, this translates into 120 potentially harmful errors each day. Similar findings have been reported by the FDA, which in its own study found that ADEs range from 2.4 percent to 6.5 percent per facility. [88]

Besides patient safety issues, MGH's decision to experiment with RFID had to do with improving workflow processes, specifically in the OR environment where more efficiency would allow the performance of more surgeries.

Cost had some influence in the decision to begin pilot testing of RFID, but the most significant influence came from patient care/safety. Some cost savings MGH expects to see from using RFID are: reduced labor costs, less manual inventories, reduced shrinkage, unnecessary equipment replacement, reduced wasted resources due to expiration and recalls, and improved workflow processes. Other benefits from doing the pilot study are to catch problems early on and resolve them, increase leadership and staff member buy-in, and if successful, implement the technology hospital-wide.

MGH chose Radianse (Lawrence, MA) as their supplier of RFID hardware. According to Mr. Spring, their market research indicated that they were best qualified to meet MGH's specific requirements. MGH had established a good working relationship with Radianse from previous projects. Currently MGH is working with them on their Operating Room of the Future (ORF) in a 4-year contract. Radianse plans to work with wireless access points, which will tie into the hospital's already existent WiFi network and easily integrate into their daily operations. The hospital uses passive tags and has spent about $150,000 for their RFID infrastructure so far. Estimated total pilot test cost will be about $400,000.

[88] Zebra Technologies, "Bar Code Applications in Life Sciences," (White Paper, Zebra Technologies, 2003).

H. PHARMACY APPLICATIONS

On February 18, 2004 the U.S. Food and Drug Administration (FDA) released its final report on ways to reduce the counterfeiting of prescription drugs. The report's recommendations include the use of RFID technology to create a "pedigree"—a secure record documenting that the drug was manufactured and distributed under safe and secure conditions. The report says it should be feasible to use RFID to track all drugs at the unit level by 2007.

Counterfeit pharmaceuticals account for 6 percent to 10 percent of all medicines sold worldwide, according to the World Health Organization. RFID and bar coding of pharmaceuticals establishes their pedigree, combats drug counterfeiting, and creates an audit trail through the value chain. Drug makers who implement bar code and RFID control systems can reduce diversion by 18 percent in the first year and lower inventory holding costs by 6 percent, according to a study by A.T. Kearney.[89]

In order to reduce diversion and lower inventory costs, MGH has embraced the Just-in-Time (JIT) inventory concept, also known as the Prime Vendor Program. The Prime Vendor program is a cooperative between medical treatment facilities and specific commercial trading partners to procure set items at established prices and guaranteed delivery times. This system was created to integrate medical supply management activity, reduce item costs, shipping time, and inventory costs for pharmaceuticals and medical/surgical items.

When MGH has a requirement for a pharmaceutical, the requisition is initiated from the hospital's main pharmacy. Within an hour, the vendor provides electronic receipt confirmation and advises on fill status that will occur with next day's shipment. On average, more than 95 percent of the order is received the next day. Thus, there is no need to store excess inventory.

In the main pharmacy, operations manager Scott Belknap demonstrated the daily operations of the main pharmacy. He explained that each day they receive a shipment of

[89] Zebra Technologies, "Bar Code Applications in Life Sciences," (White Paper, Zebra Technologies, 2003).

pharmaceuticals, based on the order placed the day prior to their prime vendor (Cardinal Healthcare). The pharmaceuticals arrive with one or two-dimensional UPC bar codes, which are scanned via handheld UPC scanners to verify the accuracy of the shipment. The drugs are then scanned once again as they are stored in an electronic carousel (smart shelves). This electronic vertical carousel (manufactured by Omnicell) consists of many shelves, segmented to hold thousands of different pharmaceuticals.[90]

When the main pharmacy fills re-supply orders from their various dispensing units throughout the hospital, the bar code is manually scanned, identifying the actual type and quantity of drug being dispensed to the unit. At this point, the accountability of the pharmaceutical, using the bar code system is complete.

The dispensing units throughout the hospital manually issue pharmaceuticals to the medical staff in their respective departments. For example at MGH, the Operating Room OR dispensing unit issues pharmaceuticals to the OR medical staff on a daily basis. There are 50 operating rooms at MGH. At the end of each day the dispensing units provide their re-supply lists to the main pharmacy to replenish their inventories. See Figure 1 for current MGH pharmaceutical source and process.

[90] Kevin Gangadeen and Bernadette Houston, interview with Scott Belknapp, September 27, 2005.

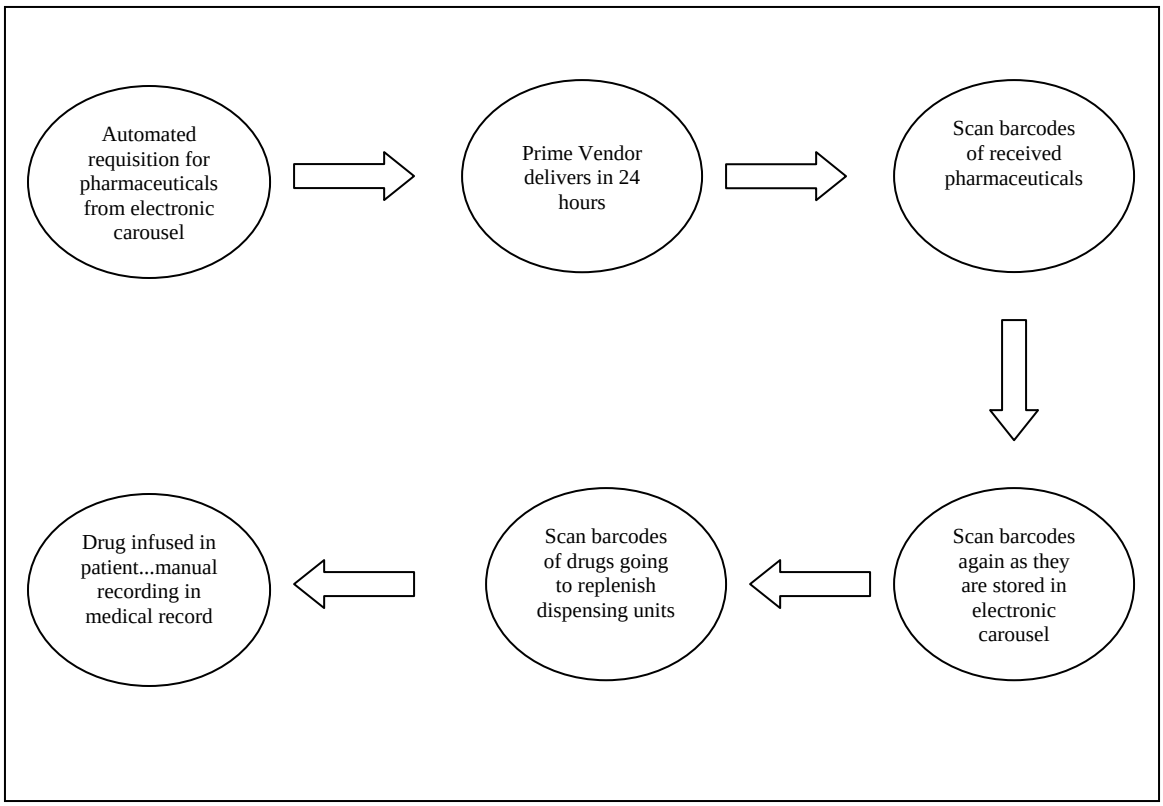

Figure 2. Current MGH Pharmaceutical Source and Process

I. MGH'S VISION OF RFID

According to Spring, information technology (IT) investment for the department makes up about 50-60 percent of their annual budget. The department purchases new PCs and emerging technology to make sure that doctors and nurses can have what they need at the palm of their hands. Network infrastructure upgrades are also budgeted annually, to prevent network overload, and in-house IT personnel are being increasingly hired to support the IT vision. And what is MGH's RFID vision? According to the staff, less labor requirements by eliminating some manual functions increasing patient-contact time, increased workflow efficiency by using "smart cabinets" tailored to the needs and/or special requirements of each department, greater efficiencies in restocking, inventory control, personnel usage and medical equipment tracking. In the near future, the use of electronic medical records (EMR) and automated blood matching, being able to track anything that goes near the patient and automatically recording it, are also on the horizon. The ultimate goal once full testing is complete and the technology proves itself,

is full diffusion throughout the entire hospital. From a pharmaceutical supply chain management perspective, RFID would track and trace drugs from the manufacturer through the distributor and ultimately to the patient. This would ensure the "pedigree" of the drugs, prevent counterfeiting, shrinkage, and provide better inventory control. The patient's EMR would be updated automatically, reducing the possibility of human error in medical transcription.

J. THE CHALLENGES OF RFID IMPLEMENTATION

Some of the major challenges identified by the staff were that they thought the technology may not be sophisticated enough to meet the unique requirements of a hospital setting, whether the technology could be tailored to meet their specific requirements, lack of universal standards within the technology, employees' resistance to change, and privacy issues. Other challenges mentioned the need for the tags to be smaller to fit on vials and other small pharmaceuticals, adequate funding for tags, and the complete infrastructure to support the tags.

MGH is learning as they go. Starting the pilot program helps them to learn more about the technology and prove its potential benefits. They are currently taking small steps to learn all of the potential benefits and doing extensive research to determine if RFID can improve their many processes.

A few significant lessons learned thus far are those processes where the human element cannot and must not be removed, or where human intervention, verification, and validation in some cases are necessary. Interoperability of the technology, for example if a patient had to be transported from one medical facility to another, would his smart-band be readable by the other facility's interrogator (reader)? How about the problem of radio frequencies not being able to penetrate leaded walls in radiology departments or not having readers with metal encasing while doing magnetic resonance imaging (MRIs). Last, but not least, privacy issues—for example, medical staff refusing to be "tagged" as they do not wish their whereabouts monitored at all times. These are just some of the challenges that any organization would face when trying to implement new technology such as RFID.

K. PRELIMINARY RESULTS (SUCCESSES)

At the time of this writing MGH was still in the first phase of its RFID pilot study. However, they have already seen many benefits from the patient and staff tracking pilot tests and foresee many other benefits manifesting in the near future, such as real-time knowledge about pharmaceuticals throughout the entire supply chain process. Belknapp predicts RFID technology's implementation in the tracking and tracing of pharmaceuticals to take place within the next couple of years, if not sooner. He agrees that the bar code system is effective to a certain extent, but there are still inefficient procedures, such as duplication, in place that would be eliminated through the use of RFID technology.

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VI. CASE STUDY – JACOBI MEDICAL CENTER

> Jacobi Medical Center's RFID-enabled patient ID system not only enhances patient care and staff working conditions, but will also save $1 million a year when fully deployed.[91]

Today, nurses and doctors at Jacobi Medical Center, the largest public hospital in the Bronx, are keeping track of patient information using RFID-enabled "smart wristbands" that can be scanned through clothing or blankets. The technology makes it easier for the medical staff to retrieve information about individual patients, and it does so without health care professionals having to disturb patients even if they are sleeping and the room is dark. The North Bronx Healthcare Network implemented the technology with the help of Siemens Business Services.

"We thought that if we could just wave a tablet PC over the patient's wrist and bring up a list of medications, allergies and other critical information, it would simplify patient identification and save clinical staff keystrokes," says Daniel Morreale, former CIO for North Bronx Healthcare Network, now at Atlantic Healthcare.[92] North Bronx Healthcare Network owns and operates Jacobi Medical Center.

A. PROFILE

Jacobi Medical Center provides quality health care for some 1.2 million Bronx and New York area residents. Founded in 1955, and named for Dr. Abraham Jacobi, the "Father of American Pediatrics", Jacobi Medical Center has a reputation for innovation. Jacobi's surgeons performed the world's first coronary bypass in 1961, and later pioneered the use of bedside minicomputers to monitor blood circulation and lung function. Its Level I trauma center houses the tri-state area's only multi-person

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[91] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

[92] Stores Magazine, National Retail Federation, "A Healthy Dose of RFID," Sep 2005, http://www.stores.org/archives/2005/09/sidebar_3.asp, October 2005.

hyperbaric chamber. The center opened an ultra-modern center for maternity and newborn care in 2001.[93]

With more than 500 beds, Jacobi Medical Center has grown into the largest public hospital in the Bronx. It offers a complete range of acute, specialty, general and psychiatric services. Jacobi also operates community-based health care centers that provide general adult and pediatric examinations and health screenings for a variety of concerns, including hypertension, diabetes, breast cancer and prostate cancer. Jacobi Medical Center is a member of the New York City Health and Hospitals Corporation, and a partner in the North Bronx Healthcare Network (NBHN).[94]

B. MISSION

Jacobi's mission states, "The patient is at the center of all our efforts. The primary mission of Jacobi Medical Center is to serve the Bronx community by providing high-quality, cost-effective health care, in a respectful way to all, regardless of ability to pay. Jacobi Medical Center also strives to achieve excellence in medical education, working in partnership with its academic affiliate, the Albert Einstein College of Medicine."[95]

C. JACOBI PREPARES FOR THE FUTURE

In 1999, Jacobi inaugurated an innovative affiliation agreement, whereby more than 375 highly qualified members of the North Central Bronx Physicians' Alliance--all with faculty appointments at the Albert Einstein College of Medicine--made a full-time commitment to NBHN. The Physicians' Alliance has already made significant progress in many areas, including reestablishing Jacobi's prominence in the areas of women's and children's health. The newborn intensive care and pediatric intensive care units are

[93] Jacobi Medical Center, Facilities, http://www.ci.nyc.ny.us/html/hhc/html/facilities/jacobi.shtml, October 2005.

[94] Ibid.

[95] Ibid.

operating at capacity, and the new pediatric short stay unit allows children who need minor surgery to go home the same day.[96]

Jacobi recently completed their renovation program to create the Center for Maternity and Newborn Care with the opening of a new 22-room maternity suite. The 45-year-old patient wing of six-bedded rooms has been transformed into a state-of-the-art birthing center. The new wing also contains specialized operating and recovery rooms for high-risk deliveries.

The network now offers six community-based Family Health Services Clinics, with the most recent 5,200 square foot health center at Gunhill. Our sites include the health centers at Crotona, Glebe, James Monroe, Tremont and two at Gunhill, with the newest on East Gunhill Road.

Recently, Jacobi Medical Center and North Central Bronx Hospital, as part of the North Bronx Healthcare Network, have been named to the list of the "Most Wired" hospital and health systems in the nation.[97] Jacobi has also won several awards for installing a robotics system that dispenses more than 2,500 unit-dose medication orders a day. They are also very proud to have received a full, three-year accreditation by the Joint Commission on the Accreditation of Health Care Organizations (JCAHO) in 1998.

D. FACT SHEET ON JACOBI MEDICAL CENTER

Jacobi's fact sheet is as follows:[98]

- Jacobi Medical Center is a member of the New York City Health and Hospitals Corporation (HHC).
- Largest Public Hospital in the Bronx (500+ beds).
- Affiliated for clinical services with the New York Medical Alliance, P.C.
- A major academic affiliate and teaching site of the Albert Einstein College of Medicine.

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[96] Jacobi Medical Center, Facilities, http://www.ci.nyc.ny.us/html/hhc/html/facilities/jacobi.shtml, October 2005.

[97] Ibid.

[98] Jacobi Medical Center, Fact Sheet, http://www.nyc.gov/html/hhc/jacobi/html/third_level/geninfo/factsheet.html, October 2005.

- Offers a complete range of acute, specialty, general care and psychiatric services.
- Offers specialized Emergency Departments for adult, pediatric and psychiatric services.
- A Level I Trauma Center (serving the North Bronx and Lower Westchester); the regional Hyperbaric Center and Regional Snakebite Center for the Tristate area.
- Operates the only multi-person emergency hyperbaric chamber in New York City.
- Operates the only Burn Unit in the Bronx, the second largest in New York City, with 30 years of clinical research and teaching experience, pioneering in early surgical intervention to preserve skin and minimize infection and injury.
- Serves as a referral center for acute psychiatry, burn care, neonatology, infectious disease, chest medicine, tropical medicine, rehabilitation and home care.
- Operates a Level III Neonatal ICU with one of the best outcome records in the United States.
- Operates a Women's Health Center, a "model" primary care program that provides the full spectrum of women's health needs from adolescence through maturity.
- Operates a state-of-the-art Outpatient Center for adult AIDS patients.
- Sponsor-approved residency and fellowship training programs in over 40 specialties and subspecialties.
- HHC "pilot" site for adaptation of electronic patient management system to create a computerized patient record.

E. RFID IMPLEMENTATION AT JACOBI

When Jacobi Medical Center considered using RFID to improve patient care and increase efficiency in its operations, RFID became another in a long line of technologies introduced to help streamline its operations. According to Morreale, "The hospital has a very pro-technology and has been for about 15 years."[99]

[99] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

Jacobi, which serves more than 1 million New York City-area residents, already operates a completely computerized physician order-entry system so that any request from a doctor—ranging from patient admission to meals to surgery or medication—is created and managed entirely electronically. In addition, around 95 percent of the hospitals health records are managed electronically.[100]

However, Morreale was looking for a way to extend the reach of its IT operations into areas where manual processes were still being used and could be made more efficient. Working with systems integrator Siemens Business Services, Jacobi deployed a pilot system that put RFID-enabled plastic wristbands on patients admitted into the two wards at the hospital's acute-care department. The pilot, which began in July last year, was set to run for just two months.[101]

During that initial trial, doctors and nursing staff used RFID readers installed in portable PCs to automatically identify each patient. The devices read the unique ID number encoded on an RFID tag embedded in the patient's wristband and opened the patient's medical file on the PC screen, enabling the patient's records to be reviewed and updated at bedside.

Two months later, when the trial was supposed to end, "The staff refused to give back the equipment, and other departments wanted to have it too," says Morreale. He maintains that the reaction from the staff alone proved the value of deploying the technology further. "The system has completely proven its worth."

According to Morreale the system has increased productivity, improved patient care and promises to create savings for the hospital as well. "The trial system saved one hour per nurse per shift. That's a $1 million saving per year if rolled out across the hospital, but more importantly that creates two to three hours in every nursing shift for additional patient contact. Patients get more time with doctors and nurses, get better faster and are more satisfied," Morreale says.[102] Not only was the trial system left up and

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[100] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

[101] Ibid.

[102] Ibid.

running, it also has been expanded to include the hospital's medical surgery unit. In addition, when the hospital moves all its wards into its planned new campus building, Morreale intends to use RFID wristbands throughout.

Designed, deployed and managed by Siemens Business Services, the pilot RFID system replaces a heavily manual system that issues patients a wristband printed with the patient's name, date of admission and unique medical record number (MRN), written both in human-readable numbers and in bar code format. To check a patient's electronic records using the old system, the medical staff had to enter the wristband's MRN into the hospital's computer system by means of PCs located at the nurses' station within each ward.

The old system also required staff to manually enter the MRN by reading the human-readable information or, when administering drugs from a medical trolley, use a handheld bar code reader to scan the MRN number printed in bar code format. However, using the bar code system proved an invasive way for staff to check a patient's identity, which must be verified before any medication or treatment can be administered. Reading a wristband's text or scanning its bar code requires a line of sight between the wristband and the staff member. Because patients are likely to have their arms under bed sheets and blankets, identifying a patient could be a disruptive procedure under the old system. (RFID tags/chips, on the other hand, can be scanned through bedcovers). "In a typical room, there are six patients, and on the midnight to 8 a.m. shift, no one wants to turn on the room lights to read a wristband or wake the patient to get access to the patients wristband bar code," says Jerry Moy, senior client executive at Siemens Business Services' U.S. arm, which is based in the Norwalk, Ct.[103]

In the two acute-care wards where the trial took place, patients usually stay less than five days, but during their time in the wards, patients will see multiple doctors and nurses across multiple shifts. So, patient identities have to be checked often, according to Moy. "We observed the existing process and then set about developing a system that

[103] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

used RFID to enable more positive interaction between care staff and patients," Moy says.

In addition to improving the way patients are identified, the trial sought to replace highly manual procedures for updating a patient's medical records. In the older system, notes on patients are written on paper and kept in three-ring binders wheeled around the wards in a library cart. When the staff needs to update information—such as a patient's medication or progress—they handwrite the information in the binder and later enter it into the patient's electronic records using a computer at the ward's nursing station. Replacing that system with the RFID tags and tablet PCs did away with having to enter the information twice—improving efficiency as well as improve working conditions for Jacobi's staff.[104]

F. THE INFRASTRUCTURE

For the trial, Siemens Business Services deployed two Zebra R402 RFID printer-encoders at the admissions office, so that as patients were checked into the hospital and assigned to the trial ward, they were issued an RFID-enabled patient wristband encoded with the patient's MRN, name, date of birth, gender in human-readable text, the patient's MRN in bar code format and other human-readable information. The bar code was included so that hospital staff could read the MRN using already existing Jacobi Medical Center lab, billing, and pharmacy information systems.

Over the course of the trial, the hospital issued the RFID wristbands to approximately 200 patients. The wristbands, which contain a passive 13.56 MHz RFID tag, were made by Precision Dynamics Corp. (PDC) located in San Fernando, Calif.,. The hospital did not deploy any fixed readers but instead equipped five tablet PCs with RF PC Handheld Readers from ACG Identification Technologies, an RFID equipment supplier based in Walluf, Germany. The readers were fitted into the PCMCIA slots of the tablet PCs.[105]

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[104] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

[105] Ibid.

Siemens Business Services also developed the software to encode the patient's medical record number on the RFID wristband's RFID tag and also developed the user interface on the tablet PCs for reading the tag.

The trial system allowed a doctor or nurse to take one of the five tablet PCs deployed for the trial from their docking stations mounted on a medical cart before staring his or her rounds. The PC's RFID reader delivered a read range of 4 to 5 inches, which enabled staff to be certain of which patient's tag was being read. Once the device read the RFID tag in a patient's wristband, an application—written by Siemens Business Services and integrated with the hospitals existing electronic patients records system—immediately displayed the patient's medical file on the PC's screen.

"What we developed was an automatic script so that whenever a patient was scanned the PC would access the clinical information system bringing up the patients records without a key stroke," says Morreale.

The PCs access the hospitals other electronic applications over a wireless network installed for the trial. Any new information to go into the patient's file can be entered directly into the patient's electronic record, doing away with any need to make handwritten notes that required later entry into the hospital's electronic record system. In addition to eliminating the bulk of its paper forms, the RFID-based system also ensures that the information used by its medical staff is always up to date.

G. THE PAYOFF

According to Morreale, the investment in the trial ($200,000) and the cost of expanding the system across the hospitals other wards is more than outweighed by the improved service enabled by the RFID-based system. "The wristbands will cost an average of $65,000 a year to cover the 47,000 admissions we have a year, and we don't need additional printer-encoders, as the admitting department already has two machines to provide some redundancy," says Morreale.[106]

[106] Jonathan Collins, "RFID Delivers Healthy Return for Hospital.," RFID Journal., http://www.rfidjournal.com/article/articleview/1537/1/80/, September 2005.

Expanding the system across other hospital operations next year will also mean spending an additional $325,000 to acquire and deploy another 165 tablet PCs equipped with RFID readers and to train staff to use them. That expense, combined with tag costs, is still well below the predicted $1 million in annual savings that the hospital projects it can make from deploying the RFID system across its patient operations.

According to Morreale, the system has increased productivity, improved patient care and promises to create substantial savings for the hospital. "We saved our nurses roughly an hour and a half to two hours a day in the time it takes to administer medications," he says. "That has a significant dollar value to us." The investment in technology is "relatively insignificant, approximately $11,000 per unit." Fully implemented in all 46 nursing stations, "we estimate that, in nurses' time alone, we can save just under a million dollars annually."[107]

But more important than the financial benefits, he adds, are "the improvements in patient safety and quality of care. Out of 100 percent positive identifications of our patients, we now have a faster, cleaner documentation of the medication process. And we have freed up the nurses to spend less time documenting and more time bedside, administering hands-on care."[108]

H. THE WAY AHEAD

Morreale is also preparing to add new applications to the system: identifying the particular procedure a surgery patient is scheduled to undergo; tracking patients' whereabouts throughout the hospital; and locating surgical instruments and blood for transfusions.

According to Mr. Joseph Dagostino, Jacobi's chief pharmacist, he believes FDA calling for the widespread use of RFID technology to track the distribution of prescription drugs and to combat counterfeit drugs by 2007 is a great idea. He clearly

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[107] Stores Magazine, National Retail Federation, "A Healthy Dose of RFID," Sep 2005, http://www.stores.org/archives/2005/09/sidebar_3.asp, October 2005.

[108] Ibid.

sees where this could be expanded to the point of drug administration tracking. As always when it comes to implementing new technologies, "… funding is always an issue," he says.[109]

[109] Kevin Gangadeen, email interview with Mr. Joseph Dagostino, Chief Pharmacist, November 9, 2005.

VII. CASE STUDY – MCKESSON CORPORATION

A. PROFILE

Originally founded in New York City as Olcott & McKesson by Charles Olcott and John Mckesson in 1833, the business began as an importer and wholesaler of botanical drugs such as herbs, roots, leaves, bark, and vegetable extract. As the business grew, Daniel Robbins joined the business and became a partner in 1840. After Olcott's death in 1853, the company was renamed as McKesson and Robbins. In the late 1800's McKesson and Robbins became one of the first wholesalers to manufacture drugs and to form a chemical division. By the beginning of the 20th Century, the wholesaler industry had stalled. McKesson and Robbins revived the drug wholesaler industry by encouraging some of the largest wholesalers to become subsidiaries. By 1955 McKesson and Robbins represented more than 100 drug companies. In 1967, the company merged with Foremost Dairies to become Foremost McKesson. Two years later, the company introduced Economost, a computer ordering entry system that forged them into the vanguard of information technology innovation. In 1983, the dairy portion of the business was sold and the company was renamed McKesson Corporation. In 1999, McKesson Corporation merged with the largest healthcare information technology business, HBO & Company, to form McKesson HBOC.[110]

Fortune Magazine recently ranked McKesson at number 16 with $69.5 billion revenue for 2004. For fiscal year 2005, McKesson has reported its revenue at $80.5 billion.[111] For fiscal year 2005, McKesson's reported revenue is $80.5 billion, a 16 percent growth from 2004. Ninety percent of this growth was driven by its Pharmaceutical Solutions segment.[112]

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[110] Datamonitor, McKesson, http://www.datamonitor.com/~da56a477aaa542db8917286552ffbfc5~/, November 2005.

[111] CBS News, Wal-Mart Tops Fortune 500 List, http://www.cbsnews.com/stories/2005/04/04/national/main685527.shtml?CMP=ILC-SearchStories, October 2005.

[112] McKesson, Annual Reports, http://www.mckesson.com/annual_reports.html, November 2005.

The company is now simply known as McKesson, the provider of supply, information, and care management products and services. Today, McKesson is headquartered in San Francisco, CA. The Chairman and Chief Executive Officer is John H. Hammergren.[113]

McKesson's motto is "Empowering Healthcare." For over 170 years, McKesson's hallmark has been service and innovation. It believes in empowering its customers with innovative thinking, technology, and exceptional service. McKesson offers three primary services: 1) pharmaceutical solutions, 2) medical-surgical solutions, and 3) information solutions.[114]

The pharmaceutical solutions segment is a pharmaceutical distribution and supply chain management unit that distributes drugs, and health and beauty care products throughout the United States and Canada. This segment also sells automated pharmaceutical dispensing systems.[115] The company's AccuMed Cabinets and others are commonly used throughout DoD's medical treatment facilities (MTFs) and civilian hospitals. The AccuMed Cabinet has the capability of counting 10 tablets per second, which is the fastest in the industry. This capability allows the pharmacies to process prescriptions efficiently, quickly, and with more accuracy. The enhanced security feature increases accuracy for medication counting, dispensing and storage technology to assist in increasing patient safety and mitigating the risk of waste.[116]

The pharmaceutical solutions segment also provides other services ranging from patient and payor services and outsourcing services to pharmacies and manufacturers. The medical-surgical solutions segment serves healthcare providers by distributing medical-surgical supplies and equipment and logistical services within the U. S. McKesson's information solutions segment offers software and outsourcing services to

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[113] McKesson, About the Company, http://www.mckesson.com/company.html, November 2005.

[114] Ibid.

[115] Datamonitor, McKesson, http://www.datamonitor.com/~da56a477aaa542db8917286552ffbfc5~/, November 2005.

[116] McKesson, Automated Prescription Systems, http://www.mckessonaps.com/wt/aps/prodserv_profiles, November 2005.

healthcare organizations throughout North America, the UK and Europe. It also provides robotics for the hospital market.[117]

McKesson is a leader in developing and promoting innovations that track the flow of pharmaceuticals and medical-surgical supplies from the manufacturers' shipping dock to the patient's use. It is the only company that provides a comprehensive system of robotics, scanning, dispensing, and software covering, which is now used in more than 250 U.S. hospitals. The company recently announced the renewal of its supply agreement with Wal-Mart. Also, it recently signed a long-term agreement with ID Biomedical, a Canadian flu vaccine manufacturer.[118]

B. MEETING THE CHALLENGE

America's drug companies are very concerned about counterfeiting. Some view their concerns about counterfeiting as a way to scare Americans away from acquiring cheaper drugs from foreign countries. Despite the skepticism, RFID technology is gaining momentum as a tool to counteract drug counterfeiting and increase consumer safety.[119] Ron Bone of McKesson says, "RFID is a way to make pedigree [requirements] workable and make the supply chain secure."[120]

Drug counterfeiting is about a $30 billion problem each year. Drug diversion or simply lost drugs is said to be an additional $40 billion problem.[121] Many of us remember the 1982 Tylenol scare. Johnson and Johnson had to recall more than 30 million bottles of Extra Strength Tylenol. The recall is remembered as a logistical nightmare. The manufacturer was oblivious of where the tampering had actually taken

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[117] Datamonitor, McKesson, http://www.datamonitor.com/~da56a477aaa542db8917286552ffbfc5~/, November 2005.

[118] Ibid.

[119] Chris Newmarker, "Drug Makers Take Aim at Counterfeiting Operations," Rednova, http://www.rednova.com/modules/news/tools.php?tool=print&id=84357, November 2005.

[120] Rick Whiting, "Drugmakers "Jumpstart' RFID Tagging of Bottles," Information Week, July 26, 2004, http://www.rfidinsights.com/shared/article/printableArticleSrc.jhtml?articleId=25600213, November 2005.

[121] Ibid.

place and where to begin to activate the recall. Therefore, it had to make a total recall. Pat Rizzotto, a Vice President of global customer initiatives at Johnson and Johnson vividly remembers the fiasco. He used the fiasco to convince senior executives that adoption of RFID technology could have assisted in avoiding the logistical nightmare.[122]

From the events described above, we can see that the pharmaceutical supply lines have vulnerabilities that must be addressed and eliminated. Many believe that RFID technology can eliminate these vulnerabilities in the pharmaceutical supply chain.

In February 2004, the Food and Drug Administration (FDA) released a report titled, "Combating Counterfeit Drugs: A Report of the Food and Drug Administration," stating the importance of adoption of new technologies to better secure our nation's drug supply. As a matter of fact, FDA postponed the promulgation of guidance, which was scheduled to be implemented in April 2004 in accordance with the Prescription Drug Marketing Act (PDMA) of 1987. The agency thought that it would be better to complete more studies and have all stakeholders move towards an electronic pedigree. FDA plans to reassess for guidance issuance in 2006.

Although FDA has not officially mandated an electronic pedigree, it is currently backing an electronic tracking system approach to meet PDMA requirements. FDA has predicted that adoption of a technology to create an electronic pedigree is feasible by 2007. In the report, FDA pointed out that RFID technology was the most promising technology available to meet the critical need of better securing our nation's pharmaceutical supply chains.[123]

McKesson has been a strong advocate of FDA's RFID technology initiatives to establish an electronic pedigree of pharmaceuticals. McKesson was one of the few companies that participated in an industry-wide test called JumpStart. The multi-disciplined team consisted of manufacturers, distributors, and retailers.[124] The team

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[122] Ann Bednarz, "RFID is Prescription for Drug Companies," NetworkWorld, June 14, 2004, http://www.networkworld.com/news/2004/061404rfid.html, November 2005.

[123] U.S. Food and Drug Administration, Combating Counterfeit Drugs: A Report of the Food and Drug Administration Annual Update, 2005 (Washington, DC: GPO, 2005), 1-2.

[124] Medical Devices & Surgical Technology Week, "Medical Device; Healthcare services support FDA policy on radio frequency identification," December 26, 2004, 250.

explored electronic product code (EPC) and RFID technologies application, restricted to the supply chain, in three key areas: 1) enhancing the safety and security of the pharmaceutical supply chain; 2) improving the process of pharmaceutical returns management, and 3) increasing the efficiency of distribution operations.[125] Accenture, an organization that specializes in consulting, technology, and outsourcing solutions packages led the project over its eight-week period.[126]

McKesson selected its Delran, NJ distribution center to participate in the JumpStart pilot project. The Delran distribution center would receive RFID tagged products through the supply chain from one of the participating manufacturers.[127] The worker would place the case of RFID tagged bottles on a table in the area where an interrogator was implanted. A computer was also located in this area to allow the worker to execute a number of scenarios involving theft, recalled drugs, outdated drugs, or other logistical errors. The distribution center would then ship a small portion of RFID tagged bottles to pharmacies. The participating pharmacies were equipped with alarms that would alert them when an incomplete or incorrect set of locations is listed on the tag; letting them know which shipments of drugs are legitimate and which were not. Pharmacy technicians were able to capture information on the individual bottles, such as the shipment date, date of manufacture, shipper and other pertinent data automatically upon receipt in the receiving area equipped with an RFID interrogator to relay information to the database.[128]

One of the lessons learned is when the tags were returned to H. D. Smith, it was found that the readability rate remained high, but when the RFID labeled bottles were tightly fitted inside a case, the individual labels were difficult to read. (During the testing, Generation 1 technologies were being used.) At times, it would take five to

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[125] Jamie Hintlian, "RFID and EPC in the Pharma Supply Chain," RFID Product News 2, no. 2 (2005), http://www.rfidproductnews.com/issues/2005.03/toc.php, November 2005.

[126] Medical Devices & Surgical Technology Week, "Medical Device; Healthcare services support FDA policy on radio frequency identification," December 26, 2004, 250.

[127] Rick Lingie, Project Jumpstart: A bird's eye view, http://www.packworld.com/cds_print.html?rec_id=18885, November 2005.

[128] Chris Newmarker, "Drug Makers Take Aim at Counterfeiting Operations," Rednova, http://www.rednova.com/modules/news/tools.php?tool=print&id=84357, November 2005.

fifteen minutes for the interrogator to read the 48 labeled bottles in a case. Executives believe that the read time and rate will be significantly improved with the advent of Generation 2 standards of hardware and software.[129]

Another one of the lessons learned by McKesson and its partners in the JumpStart project was the need to eliminate the privacy concerns of a RFID tagged bottle being passed on to the consumer. The team worked closely together to make the tag removable at the retailer level while continuing to be securely attached to the bottle during transportation through the supply chain. The vendor of the RFID imbedded label implemented the solution of applying a two-ply tag with a clear base that was tightly secured to the product, and an RFID tag that could be easily peeled off by the pharmacist. The team also worked with EPCglobal and FDA to ensure industry compliance.[130]

Specialized skills requirement for RFID/EPC projects is another important lesson learned during the JumpStart project. The implementation of RFID technology involves the integration of many functions within an organization. In order for the implementation to be successful, there must be good coordination and organization-wide involvement. If there is a third party logistics partner involved in the supply chain management of its products, there must be a good working relationship between the two.[131] The third party partners must clearly understand the organization's vision for RFID technology.

It was also learned that a full roll-out implementation of RFID technology in the pharmaceutical industry is a lot more complex that many may have originally thought. The pharmaceutical industry is a highly regulated industry that may require more time than an average retailer, such as Wal-Mart to refine its unique issues and proceed with full implementation. The infrastructure cost may also be exceptionally higher than any other industry as well.[132] The United Press International of The Washington Times reported Ed Lang, a spokesman for McKesson, saying "the "Big Three" of the

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[129] Rick Lingie, Project Jumpstart: A bird's eye view, http://www.packworld.com/cds_print.html?rec_id=18885, November 2005.

[130] Jamie Hintlian, "RFID and EPC in the Pharma Supply Chain," RFID Product News 2, no. 2 (2005), http://www.rfidproductnews.com/issues/2005.03/toc.php, November 2005.

[131] Ibid.

[132] Ibid.

pharmaceutical distributors, with McKesson being the largest, share a unique vantage point, carefully monitoring the movement of about 90 percent of the nation's drugs from manufacturers to pharmacies. Distributors like McKesson understand the complexity of getting each individual customer the exact drug they need, in the right place, at the right time."[133]

In our opinion, the most important lesson learned was the power of partnership. The collaborative voices, cross-supply-chain approach truly defined effectiveness in pooling of resources and sharing of developmental information. The collaborative efforts alleviated unnecessary work and allowed better development of solutions that were in compliance with FDA's guidance.[134]

The JumpStart pilot study clearly identified some shortfalls in the current RFID technology systems that need to be addressed by the technology industry. The pilot study also quickly proved the value of RFID technology in counterfeit detection, logistics management of recalled drugs, management of near expiration drugs, reverse logistics or returns of pharmaceuticals. In conclusion, Accenture and the participants in this phase of the JumpStart project ventured to say that RFID technology is an effective tool to be used to significantly improve the security and efficiency of the pharmaceutical supply chain.[135]

C. MOVING FORWARD

In September 2005, we conducted a telephone interview with Ron Bone, Senior Vice President of Distribution Support at McKesson. Ron Bone is responsible for the field implementation of the SD Module of SAP as well as for operation processes and regulatory issues for the pharmaceutical supply division of McKesson. He has worked for McKesson for 32 years in a number of senior operations and sales management

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[133] Jean J. Koprowski, "Wireless World: Drugs Next Stage for RFID," The Washington Times, United Press International., November 19, 2005, http://washingtontimes.com/upi-breaking/20041118-072727-2647r.htm, November 2005.

[134] Ibid.

[135] Ibid.

positions. Currently, he is McKesson's lead agent for RFID implementation and supply chain issues.[136]

During our interview, we asked Bone, to share what he thought were some of the industry concerns. He stated that the lack of international standards for serialization is a major concern. There's a critical need for unique serialized numbers on each bottle to create an electronic pedigree. Another concern is communication barriers. At every point of the pharmaceutical supply chain, there is a challenge for parties to pass data or share pertinent information to increase the effectiveness of the supply chain management. Incompatibility between the RFID chip and reader is pretty common right now. There are hopes that Generation 2 hardware will resolve the incompatibility problem. Environmental interferences, such as water and metal are hoped to be significantly reduced, if not eliminated by Generation 2, is another concern. Bone and others strongly believe that the tagging process needs to start with the branded manufacturer, then the generic manufacturer. This will not only begin the critical process of creating an electronic pedigree for each drug, but also assist in lowering the cost of the RFID tag. The current cost of an RFID tag ranges from .25 to .35 cents. Bone says that the goal is to lower the cost of the tag to .05 cents. The last, but most certainly not the least concern is human behavior. Overcoming resistance to change is one of the biggest hurdles.[137]

When we asked Bone if McKesson was considered to be the market leader in implementing RFID, he confidently said, "yes." Not only does he believe that Mckesson is the leader, but he says that the pharmaceutical industry and the business application consultants believe it as well.[138]

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[136] RFID Journal., "RFID Journal Live! 2005 Speakers," http://www.rfidjournallive.com/speaker_af.htm, November 2005.

[137] Kevin Gangadeen and Bernadette Houston, telephone interview with Ron Bone, September 23, 2005.

[138] Ibid.

D. CONCLUSION

Although phase one of the JumpStart project has ended, McKesson continues to expand the use of RFID technology in its distribution centers located within the United States. It is also expanding the application of the emerging technology in the development of new business processes within the company.[139]

Accenture plans to deploy phase two of the JumpStart project in the near future. Phase two of the JumpStart project involves them having a more intimate relationship with the individual pharmaceutical companies. Accenture will take a close look at the requirements of an individual company to develop and assist in the implementation of the best RFID technology integration strategy for the individual company.[140]

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[139] Jean J. Koprowski, "Wireless World: Drugs Next Stage for RFID," The Washington Times, United Press International., November 19, 2005, http://washingtontimes.com/upi-breaking/20041118-072727-2647r.htm, November 2005.

[140] Jamie Hintlian, "RFID and EPC in the Pharma Supply Chain," RFID Product News 2, no. 2 (2005), http://www.rfidproductnews.com/issues/2005.03/toc.php, November 2005.

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VIII. CASE STUDY - H. D. SMITH WHOLESALE DRUG COMPANY

A. PROFILE

Springfield, Illinois is not only known for the place where our 16th president, Abraham Lincoln, began to practice law.[141] It is also home to the seventh largest wholesale drug distributor in the United States, H. D. Smith Wholesale Drug Distributor. Named after its founder Henry Dale Smith in 1954, it has consistently grown from a small metropolitan distributor to a nationally acclaimed full line distributor. H. D. Smith's growth stems from a combination of new facility expansion plans and acquisitions, such as the acquisition of Texas Drug Company in Ft. Worth, Texas, the Barnes Wholesale Drug, Inc. located in Inglewood, California, and its most recent acquisition of J.J. Balan, Inc., a telemarketing firm located in the New York Metro area that sells generic pharmaceuticals nationwide. With annual revenues in excess of $1.5 billion, today it operates six distribution centers strategically located within the United States.[142]

H. D. Smith's motto is "Excellence in wholesale drug distribution." It is known for continually developing solutions to increase efficiency and exceed customer expectations. To achieve this, it offers much more than branded and generic pharmaceutical distribution services. Its product line consist of more than 35,000 line items to not only include pharmaceuticals, but also over-the-counter/health-and-beauty care (OTC/HBC) products, home healthcare products, surgical supplies, and seasonal merchandise. It also offers an array of marketing programs. While staying in compliance with all Food and Drug Agency (FDA), Drug Enforcement Agency (DEA), Environmental Protection Agency (EPA), Department of Environmental Protection (DEP), and Department of Transportation (DOT) regulations, its number one goal is to offer an array of services and technology solutions to address the business needs of its

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[141] Encyclopedia Wikipedia, "Abraham Lincoln," http://en.wikipedia.org/wiki/Abraham_Lincoln, November 2005.

[142] H. D. Smith, Company Background, http://www.hdsmith.com/Marketing/CompanyBios.aspx, October 2005.

customers. Its customer base includes pharmacies, hospitals and specialty care providers.[143] Today, the founder, Henry Dale Smith presides as Chairman and his son, Henry Dale Smith, Jr. is the President and Chief Executive Officer for H. D. Smith.[144]

B. MEETING THE CHALLENGE

Jamie Hintlian, a partner in the health and life sciences practice at Accenture, reported that between 2% and 7% of pharmaceuticals in the U.S. are counterfeited. According to FDA, the percentage could be as high as 50% in some countries. To say the least, drug counterfeiting is a serious threat to public health.[145] H. D. Smith is known for its innovation and adaptability in serving its customers. It continually seeks opportunities to improve patient safety, increasing inventory efficiency, and increase supply chain integrity. To counteract drug counterfeiting to maximize patient safety is very important to the company, says Robert E. Kashmer, Vice President of Information Technology for H. D. Smith. Kashmer goes on to say that "Pharmacists are one of the most trusted professions in the world. We want to protect that supply chain. Establishing an electronic pedigree for the products we handle is very important to us."[146]

Since its inception, H. D. Smith has developed a reputation of continually seeking avenues to improve service to its healthcare providers, improve inventory management, improve supply chain management, and most importantly increase patient safety. Around mid 2004, H.D. Smith decided to transform its barcode record keeping process into a high tech automated process. It made the bold and significant business investment decision to begin testing RFID technology in three phases. It partnered with then RFID solutions provider, Matrics (now Symbol Technologies, Inc.), to implement the best plan to meet its business requirements. Matrics chose Franwell, a systems integrator, mostly

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[143] H. D. Smith, Company Background, http://www.hdsmith.com/Marketing/CompanyBios.aspx, November 2005.

[144] H. D. Smith, Executive Bios, http://www.hdsmith.com/Marketing/ExecBios.aspx, November 2005.

[145] Ann Bednarz, "RFID is Prescription for Drug Companies." NetworkWorld, June 14, 2004, http://www.networkworld.com/news/2004/061404rfid.html, November 2005.

[146] Jonathan Collins, "Tracking Control-Substance Drugs," RFID Journal., June 29, 2004, http://www.rfidjournal.com/article/articleprint/1006/-1/1/, November 2005.

known in the agricultural produce/food industry, to support the first phase as the equipment integrator. As the integrator, Franwell developed a Barcode/RFID receiving and shipping application for H. D. Smith's distribution centers.[147]

The secured vault, in which the Schedule II drugs are stored while located in the distribution center, was equipped with an RFID system. Prior to the drug being stored in the secured vault, employees would manually place an ultra high frequency (UHF) tag, which is 915 MHz, on each bottle for tracking. This was necessary because at the beginning of H. D. Smith's pilot study no pharmaceutical manufacturer was tagging the bottle.[148] The goal is to eventually have every bottle tagged at the manufacturer. Bottles would then be placed in a tote and carried to the secured vault. The RFID system would track the Schedule II drugs as they were received and removed for shipment from the secured vault. Many times, employees would have to manipulate the position of the bottles in the tote to achieve 100 percent tag readability.[149] H. D. Smith believes that tag position manipulation will decrease and eventually be alleviated as the system is refined. As the interrogator aggregately reads the tag, H. D. Smith's inventory program is automatically updated with pertinent information. This phase of the pilot study involved 20,000 to 100,000 bottles of pharmaceuticals being tagged with passive RFID tags.[150]

As mentioned earlier, H. D. Smith's goal is to track pharmaceuticals across the complete supply chain to obtain a full electronic pedigree of each product. To get closer to achieving this goal, it progressed its RFID technology pilot study to phase two, which included testing at one of its retailer sites, a pharmacy. Kashmer, states that the individually RFID-tagged bottles are packaged in bulk units to be distributed only to the pharmacy. Prescriptions will be filled by the pharmacist from these bulk units. An RFID

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[147] Steve Webb, "Build An Electronic Pedigree," Integrated Solutions, January 2005, http://www.integratedsolutionsmag.com/Articles/2005_01/050104.htm, November 2005.

[148] Ibid.

[149] Ibid.

[150] Globe Ranger, Pharmaceutical Wholesaler Leverages RFID to Generate Electronic Pedigree for Schedule II Drugs, http://www.globeranger.com/documents/FINAL_HDSmith.pdf, November 2005.

tag will not be attached to the consumers' individual prescription bottle.[151] This eliminates the privacy concerns of individual consumer information being imbedded on an RFID tag.

H.D. Smith has installed an interrogator at the receiving station at its customer site so that electronic receipt verification can be made of an entire order. Each container in which each RFID-tagged bottle is shipped has a barcode which is scanned by the workforce. The container is then sent to the interrogator imbedded area of the receiving station so that the RFID tags on the bottle can be automatically read. The unique electronic product codes are matched with codes recorded on the manifest. The worker allows the automated read to continue until there is complete reconciliation. If an expectant code is not detected, then the worker will make adjustments to the shipping container contents. This adjustment is automatically forwarded to H. D. Smith. H. D. Smith is now able to capture pertinent information real-time via the integration of its RFID system and Internet E-Receiving Program.[152]

H. D. Smith's final stage to complete the process of creating an electronic drug pedigree is receiving RFID labeled drugs from the manufacturer. This phase will assist in giving H. D. Smith more insight, management, and control of the product inventory as it strives to develop electronic pedigree solutions. Being an early adopter of RFID technology integration into its business management systems, positioned H. D. Smith to participate in Purdue Pharma's "smart tagging" project.[153]

C. PURDUE PHARMA

Purdue Pharma is a privately-held company based in Stamford, CT, known for making the infamous Schedule II narcotic, OxyContin, a pain killer. Purdue Pharma's

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[151] Kurt Menges, "Drug Wholesaler Adopts RFID to Track Control Substances," RFID Solutions, July 27, 2004, http://www.rfidsolutionsonline.com/content/news/article.asp?docid={23ef49b7-5d9a-40ca-bd6f-695e0ae44106, November 2005.

[152] Globe Ranger, "Pharmaceutical Wholesaler Leverages RFID to Generate Electronic Pedigree for Schedule II Drugs," http://www.globeranger.com/documents/FINAL_HDSmith.pdf, November 2005.

[153] H. D. Smith, News Release, http://www.hdsmith.com/Docs/HDSRFID2NewsRelease.pdf, November 2005.

executives, Aaron Graham, VP and Chief Security Officer, Chuck Nardi, Chief Information Officer, and David Richiger, executive director of package design and development, believe that RFID is the way of the future and would eventually deliver benefits to everyone in the value chain by deterring counterfeiting, reducing diversion, and ensuring authenticity to increase patient safety. Purdue Pharma is reported as being the first in the world to implement RFID technology security features into its individual bottle packaging program. The RFID technology implementation would allow Purdue Pharma to capture necessary data from the time the drug moved from the packaging stage to the highly secured vault and then to the shipping area to be transported to the customer, such as H. D. Smith or Wal-Mart.[154] To give a complete picture of the amount of testing invested in RFID technology, we believe it's important to share the story of Purdue Pharma's pilot study.

In November 2003, the world's largest retailer, Wal-Mart, announced its mandate requiring all of its inbound Schedule II narcotics be RFID-tagged down to the bottle. Purdue Pharma, a leading pharmaceutical manufacturer and supplier to Wal-Mart decided to pioneer the implementation of RFID technology into the pharmaceutical manufacturing industry. Purdue Pharma didn't just want to be in compliance with Wal-Mart's mandate, but it made the risky decision to integrate RFID technology into its current business systems to capture pertinent data as the drug moved from the packaging area, to the highly secured vault for Schedule II narcotics and then to the shipping area. A couple of Purdue Pharma's executives, David Richiger and Chuck Nardi led the company in its business processes and systems transformation. They quickly developed a multi-disciplined process team of key personnel to engineer a tailored RFID technology application. Due to the fact that Matrics was currently delivering 1" by 1" tags that would properly fit small pill bottles, Purdue Pharma quickly chose Matrics (now Symbol Technologies, Inc.) as its RFID technology provider. Matrics quickly collaborated with SAP to engineer a prototype system that would interface Matrics' readers with SAP's

[154] Mark Roberti, "Purdue Pharma Gets Down to the Item," RFID Journal., January/February 2005, 14.

cross-functional business system.[155] SAP is a provider of enterprise resource planning (ERP) systems used to automate and integrate corporate cross functions such as inventory management, distribution, procurement, finance and more.[156] Originally, tests were performed with a case of 72 RFID-tagged bottles. It was immediately discovered that the interrogator required a significant amount of time to read all 72 bottles. Many times the interrogator was unable to read the RFID-tagged bottles in the center of the case. That's when Purdue Pharma decided to reduce the case to 48 RFID-tagged bottles. The tests with 48-RFID-tagged bottles quickly proved that Matrics' reader was capable of capturing and relaying the unique EPC of 48 RFID-tagged bottles within more than 10 feet of the antenna through the middleware provided by SAP almost instantly. Purdue Pharma was ready to move forward with the project, but not without a few challenges along the way.[157]

The first challenge was met when it was time to integrate the RFID tag into the product label. Due to space constraints, Purdue Pharma had to have the tag and label integration take place off-site. Its label providers had limited capabilities. So, Purdue Pharma began collaboration with Guilford Gravure, a label maker in Guilford, CT, in the design of a special anti-counterfeiting characteristic of the label that would be integrated into the label before being distributed to Purdue Pharma. Matrics would send the RFID tag to Guilford Gravure for integration into the product label. After which, Guilford Gravure would forward the RFID imbedded label to Purdue Pharma.[158]

The second challenge to overcome was identifying defective RFID imbedded labels before placing them on the bottle. Once the label was attached to the bottle, it was very expensive in time and dollars to remove the label. First, the cycle time would be significantly increased because the product would have to be removed from the assembly

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[155] Mark Roberti, "Purdue Pharma Gets Down to the Item," RFID Journal., January/February 2005, 14.

[156] J. Michael Tarn et al., "Exploring the rationales for ERP and SCM Integration," Industrial Management & Data Systems 102 , no. 1 (2002): 26.

[157] Mark Roberti, "Purdue Pharma Gets Down to the Item," RFID Journal., January/February 2005, 16.

[158] Ibid., 15.

line, the label would have to be manually removed, and the bottle would have to be sent back through the process of having another label attached. Having a large amount of defects could become very costly in dollars, as well. Nardi says, "We operated under a strict internal directive to ensure that RFID-enabling the packaging line didn't negatively impact cycle time."[159] To meet the challenge, Purdue Pharma worked even more closely with Matrics to increase the quality of the RFID tag. Purdue Pharma's action to work with the supplier in decreasing the defective rate is a blatant example of one of the many quality characteristics of lean production, coined by the Japanese automobile industry. Matrics has now expanded its inspection of the RFID tags to an automated process prior to being shipped to the label maker. Immediately upon receipt by Guilford Gravure, the tags are scrutinized again to ensure no damage has taken place during the transition and the tag still meets Purdue Pharma's requirements. Once the tags and the labels are married, they are tested again to ensure degradation of quality has not taken place during the integration process. If quality is degraded, the RFID imbedded label is rejected.[160]

The third challenge was ensuring that the RFID imbedded label was not damaged during transit of the drug from Purdue Pharma shipping area to the customer, the retailer (pharmacy or hospital). That's when senior package development engineer, Harry Ramsey established a series of shock and vibration tests. The tests included repeated subjection to extreme temperatures ranging from 4 to 130 degrees Fahrenheit and repeated drops. The test products were shipped to Wal-Mart, which was able to read each tag being tested. At this point, the durability test of the RFID-imbedded label was complete. Its efficacy had been proven.[161]

The final challenge came with ensuring that the EPC matched the right drug strength. Pharmaceuticals are manufactured at different strengths. For example, OxyContin comes in 10, 20, 40, and 80 milligrams. Purdue Pharma had to develop a system to ensure that the right unique EPC was attached to the appropriate strength

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[159] Mark Roberti, "Purdue Pharma Gets Down to the Item," RFID Journal., January/February 2005, 14.

[160] Ibid., 15.

[161] Ibid., 16.

version of drug. Again, Purdue Pharma worked very closely with Matrics to develop and refine a system that would reject a bottle that had a label with conflicting EPC and strength information. It takes about a half a second read the tag, match the EPC with drug strength information, and ensure there is no duplicate EPC. If there is a mismatch or duplication the system sends a message to have a burst of air emitted to blow the rejected bottle off of the line into a receptacle. Acceptable bottles are grouped in eight lots of six, placed in a case and sealed with a tamper-resistant tape. The cased bottles traveled on the conveyer to be read by another antenna. The antenna has five seconds to interrogate the labels. If there is a duplicate EPC, or fewer than 48 bottles are read, the system automatically stops the line and allows the supervisor to manually investigate the problem. If all 48 bottles are read properly, the cased bottles are individually sent to another conveyer equipped with another antenna that reads and relays pertinent information prior to the Schedule II drug being stored in the secured vault. When an order is received, based on criteria set by Purdue Pharma, a pick list indicating to the worker what products and the shelves from which the products were to be removed. When the drugs are removed from the vault, they are sent down another conveyer to have labels read again prior to shipment to the customer. This process allows Purdue Pharma to track and trace specific bottles sent to the customer. In the future, Purdue Pharma also sees this feature being used to forward the customer an advance shipping notice (ASN).[162]

After a $2 million investment and extensive successful testing, history is made. Purdue Pharma is the first to provide a fully integrated, anti-counterfeiting packaging designed to protect Schedule II drugs from diversion and counterfeiting.[163] In November 2004, Purdue Pharma decided to go prime time with its first shipment to Wal-Mart. At

[162] Mark Roberti, "Purdue Pharma Gets Down to the Item," RFID Journal., January/February 2005, 16-20.

[163] Heather Won Tesoriero, "Purdue Pharma, H. D. Smith Plan Test of Electronic Tracking of Drugs," The Wall Street Journal., May 31, 2005, http://www.proquest.com, November 2005.

this time, it also decided to begin a pilot study of shipping RFID labeled bottles to the seventh largest U.S. drug distributor, H. D. Smith.[164]

D. MOVING FORWARD

In mid-2005, it was announced that the electronic pedigree tracking pilot study with Purdue Pharma and H. D. Smith would be put to the test in July 2005. The popular painkiller, OxyContin would be used for the test.[165] The companies selected to be used for this phase were Unisys Corporation, globally known for information technology services and solutions and SupplyScape, a leader in defining a universal standards-based electronic pedigree solution for the pharmaceutical industry. Unisys and SupplyScape both believe that this project will lead the way to establishing national standards for tracking and tracing pharmaceuticals and will significantly stunt the growth of pharmaceutical industry losses due to vulnerabilities within its supply chain, which opens the door to fraud. Intel Corporation will assist the companies by efficiently managing the huge flow of data that the RFID tracking system will generate.[166] Post appraisals for this test have not yet been published.

In October 2005, we conducted a telephone interview with Robert Kashmer, Vice President of Information Technology for H. D. Smith. Robert Kashmer joined the company in 1995 and has over 25 years of wholesale and retail drug chain experience. His extensive background in information technology paved the way for H. D. Smith to become a pioneer in testing RFID technology. His expertise and quickness to respond to the changing needs not only of the company, but also of the entire pharmaceutical industry readied H. D. Smith to collaborate with Purdue Pharma in developing an electronic pedigree system for pharmaceuticals.

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[164] Caroline Van Hasselt, "When Barcodes Aren't Good Enough," Treasury & Risk Management, December/January 2005, 17.

[165] Won Tesoriero, "Purdue Pharma, H. D. Smith Plan Test of Electronic Tracking of Drugs," The Wall Street Journal., May 31, 2005, http://www.proquest.com, November 2005.

[166] SupplyScape, SupplyScape and Unisys Pilot Pharmaceutical Industry's First Electronic Pedigree System for Commercial Drugs, http://www.supplyscape.com/company/press/20050531a.php, November 2005.

Kashmer states that the company is very pleased with the progress of the pilot study. He strongly believes in the many benefits that RFID technology offers. The tags are reliable, but they are currently working on refining the conveyer system. H. D. Smith plans to continue to automate small scale before full implementation. This will allow the opportunity to thoroughly test the system and continue to work out the bugs. We asked if it was difficult to create buy-in from the staff. He stated, "No" and goes on to say that each of its six distribution centers (DC) wanted to be selected as the pilot site. There was actually competition between the DC's to get selected as the pilot site. The staff was very eager to explore opportunities to improve processes. Very little training would be required due to the systems integration lead by Franwell and the middleware being user-friendly. Business processes did not have to be molded around RFID. H. D. Smith was able to continue using its current business processes, such as its E-Receiving program. RFID technology basically enhanced its data collection capability.

Kashmer states that current and future mandates and lawsuits did not have an influence on the decision for H. D. Smith's early adoption of RFID technology. The company simply saw the huge benefits offered in product handling/logistics and product/supply chain integrity. We asked what the benefits of working with a consultant company were. Kashmer pointed out that there were many, such as close examination of current business processes to outline uses for RFID now and in the future. Most small to medium size business don't have the revenue to completely overhaul its information system. A consultant will consider current and future deployment and determine how RFID technology may best be integrated into current systems. When Kashmer was asked if H. D. Smith considers itself a market leader in implementing RFID technology, he modestly responded that H. D. Smith is one of the leaders. H. D. Smith plans to begin a pilot study with Pfizer, a major pharmaceutical manufacturer, using 13.56 MHz RFID systems.[167]

[167] Kevin Gangadeen and Bernadette Houston, telephone interview with Robert Kashmer, October 13, 2005.

E. CONCLUSION

Although H. D. Smith's main goal is to increase visibility of products to increase patient safety, the company does plan to reap cost savings benefits through a significant improvement of its inventory management. The company believes that the extensive cost is worth the customer service benefits.[168]

[168] Steve Webb, "Build An Electronic Pedigree," Integrated Solutions, January 2005, http://www.integratedsolutionsmag.com/Articles/2005_01/050104.htm, November 2005.

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IX. ANALYSIS

The pharmaceutical industry is one of the most vital segments of today's economy. In light of drug counterfeiting, recalls, and increased emphasis on inventory management, the demand for more accurate information and real-time tracking has forged the industry and FDA to look for new technologies to meet the demand. Today, FDA strongly supports a reliable electronic track and trace technology over a paper generated pedigree of pharmaceuticals. It has identified RFID technology as the most promising technology to meet the pharmaceutical industry's 21st century requirements.

In previous chapters, we took an in depth look at RFID pilot studies for four organizations. The four organizations were: 1) Massachusetts General Hospital; 2) Jacobi Medical Center; 3) H. D. Smith and Purdue Pharma; 4) McKesson. Purdue Pharma's pilot study was described in H. D. Smith's case study due to the partnership in deploying phase three of H. D. Smith's pilot study.

In this analysis we will give an overview of each of the organization's pilot study. Although the overall purpose of each study was to test the concept of RFID technology in the applications in which it would be used, we identified the organization's individual reasons for conducting a pilot study. We also identified the individual design of the pilot studies, the level of experimentation, and individual future plans for the organization, in regards to furthering its study of RFID technology.

Based on our analysis (see Table 2) there were four common patterns we observed in the four organizations: 1) Experimentation, 2) Consultation, 3) Culture, and 4) Standardization. We rated them on a scale of 1 (low) to 3 (high) in each category and totaled the results to determine the leader in each sector. In the wholesale/distribution sector, McKesson won over H.D. Smith based on their long history of an organizational culture that is not afraid of change and their work with various RFID standard making bodies.

In the hospital sector, MGH beat Jacobi across the board except in the area of consultation where MGH chooses to use its employees instead of hiring outside

consultants to help them implement RFID technology. MGH feels it hires the best and brightest employees who understand its operational environment and culture more than an outside consultant could ever learn in a few months.

Table 2. Analysis Chart

	Experimentation	Consultation	Culture	Standardization	Total
MGH	3	1	3	3	10
Jacobi	2	3	2	1	8
McKesson	3	3	3	3	12
HD Smith	2	3	2	1	8

In sections A, B, C, and D, we address or four key areas in more detail. From these key areas, we identified some challenges (section E) that were addressed during the pilot study and some areas that should be addressed by the pharmaceutical and the technology industries in the near future before a successful full implementation of RFID technology can take place. The analysis of each organization's pilot study helps to bring clarity to where the pharmaceutical industry really is in implementation and addressing the challenges that have been brought to light thus far.

A. EXPERIMENTATION

RFID technology has been around for quite some time and has been successfully used in many applications. Today, it is in the early stages of being used in the pharmaceutical industry. Therefore, quite a bit of experimentation/investigation is required to learn more about how the technology would respond to the particulars of a very complex, extremely sensitive, and highly regulated industry.

Many have stated that RFID technology has limitless potential benefits for the industry, but the industry needs to continue to look for results that substantiate the claim. Therefore, before embarking on the major undertaking of fully implementing RFID technology throughout the entire industry, small multi-disciplined groups have come together to test the technology on a small scale. This strategy would afford the industry to resolve any problems before full deployment. Often, there are many issues to be tweaked such as the choice of participants, the extent of testing, the level of testing by

each organization within the group, and much more. Some individual organizations have or are completing pilot studies to try to prove the benefits as well. Completing a pilot study first can also be a cost saving. In some cases, an initiative is either partially or completely abandoned as a result of a pilot study. All of the organizations we chose for this study agreed that the overall purpose of the pilot study was to allow RFID technology to prove its efficacy and improve processes that would increase patient safety.

1. Massachusetts General Hospital (MGH)

MGH started its pilot study with patient tracking in the summer of 2004. It has since expanded its study to staff tracking and its Operation Room of the Future (ORF) concept. RFID-embedded equipment, such as "smart cabinets" that are used by anesthesiologists to track and inventory drug and device usage are a major part of the ORF concept. MGH pointed out that the "smart cabinets" need to be refined to meet the life-saving requirements of an anesthesiologist. Time is of essence when a patient is anesthetized and then brought back to consciousness. The current "smart cabinet" being tested in the ORF does not improve workflow processes for the anesthesiologist. The required login and inventory processes are quite slow, adding time to the current overall workflow process. Therefore, it was determined that a secured "smart cabinet" would most likely not be placed in an OR unless the login and inventory processes were significantly improved.

Through the pilot study, MGH has also learned that RFID technology is still in its infancy stage. There is a significant amount of incompatibility between equipment manufacturers. The smaller the tag is made the more readability is degraded. There were a number of other limitations revealed during the pilot study. As Dr. Goldman said, "In reality, it's all about logistics, infrastructure, and systems."

MGH admits that it's taking small steps to try to learn all of the potential benefits and pitfalls of the technology early on. This allows them to work through the bugs at a cheaper cost. MGH wants to determine if RFID technology can really resolve the issues it faces. Although leadership already supports the testing of RFID technology, the pilot study will afford the opportunity to increase leadership buy-in even more and increase the buy-in of staff members. In the future, MGH plans to implement RFID technology in the

pharmacy department, medical equipment tracking, blood supply, electronic medical records, and more.

2. Jacobi Medical Center

Jacobi Medical Center began its pilot study of RFID technology in July 2004 in its acute care department and expanded it to its medical surgical unit. The purpose of the pilot study was to prove that RFID technology could improve the center's patient identification process and replace heavily manual processes used for updating patients' medical records. Today, close to 95 percent of the center's health records are managed electronically. In the initial stage of the pilot, patients were issued a "smart band" wristband at check-in, while the medical staff was equipped with a radio frequency (RF) embedded tablet PC. When the "smart band" was scanned, the patient's medical record was automatically opened for viewing and updated on the tablet PC. After the initial study, Jacobi refined the process by encoding pertinent information, such as the patient's name, date of check-in and assigned medical record number (MRN) on the "smart band" chip. Within a 4-5 inch range, medical staff was able to scan the patient's "smart band" through clothing and with limited lighting to identify the patient without disturbing them. Medical staff were also able to update patient information without having to manually key in the patients uniquely assigned MRN. The pilot study ended after a short two month period. The "smart band" application was immediately adopted and expanded to other departments due to popular demand. As a result of the testing, Jacobi quickly began to see benefits of RFID technology through improved patient care, improved workflow processes, and cost savings. Jacobi predicts an annual $1 million savings upon full deployment in patient identification and medical records update. Jacobi is hoping to explore other applications of RFID technology including inventory management of its pharmaceuticals, but due to limited funding for experimentation is not sure when further study will take place.

3. McKesson

As part of the JumpStart project, McKesson began its pilot study in early 2004. The study continued until September 2004. The purpose for the study was to explore

how application of EPC/RFID technology in the pharmaceutical supply chain could improve performance.

During the study, the team of multi-disciplined members explored EPC/RFID technologies application in three key areas: 1) enhancing the safety and security of the pharmaceutical supply chain; 2) improving the process of pharmaceutical returns management; and 3) increasing the efficiency of distribution operations. During the JumpStart experimentation, many challenges were brought to light. Generation 1 technology read a tightly fitted case of 48 RFID tagged bottles very slowly. It took anywhere from 5-15 minutes for the interrogator to read the tags. This read rate is expected to improve with the advent of Generation 2 standards of hardware and software.

The team worked closely with the vendor to eliminate privacy concerns by making the tag removable at the retailer level, while continuing to be securely attached to the bottle during transportation through the supply chain. The vendor of the RFID embedded label implemented the solution of applying a two-ply tag with a clear base that was tightly secured to the product, and an RFID tag that could be easily peeled off by the pharmacist.

It was also learned that implementation of RFID technology involves the integration of many functions within an organization. Therefore, specialized skills and effective communication of the company's vision of RFID is required.

Full roll-out of RFID technology can be very complex in the pharmaceutical industry. With the industry being highly regulated and very temperature sensitive, it may require more time than other industries to implement. Due to the size of a hospital, the infrastructure cost may also be exceptionally higher than any other industry as well.

The power of partnership was clearly identified during the project. Collaborative efforts proved to be invaluable throughout the entire supply chain. The sharing of information alleviated unnecessary work and allowed better development of solutions that are aligned with FDA goals.

McKesson remains actively involved in a number of committees within Healthcare and Life Sciences Business Action Group of EPCglobal, which is the industry

organization overseeing the establishment of standards for the use of EPC/RFID.[169] McKesson also continues test and expand the applications of RFID technology into its business processes.

4. H. D. Smith

H. D. Smith began its pilot study around June 2004. Its purpose for starting a pilot study of RFID technology was to track Schedule II drugs across its distribution channels in a continuing effort to improve product safety, inventory management, and supply chain integrity. It decided to test RFID technology in three phases to incrementally build the pathway of creating an electronic pedigree for its Schedule II narcotics.

H. D. Smith hired Matrics (now Symbol Technologies, Inc.) to assist in determining the best plan to meet its business requirements. Matrics decided that system integration was the best solution for H. D. Smith. Matrics selected Franwell as the systems integrator, which developed a bar code/RFID receiving and shipping application for the company's distribution centers.

Early on in the pilot study, H. D. Smith realized that the read rate was not acceptable without the worker having to manipulate the position of the RFID tagged bottles in the tote.

During the second phase of H. D. Smith's pilot study, it partnered with one of its retailers. H. D. Smith installed interrogators in the receiving station at the retailer site so that electronic receipt verification could be made of the pharmacy's order. With the RFID system being integrated with its web-based E-Receiving Program, H. D. Smith is now able to capture pertinent information about the retailer's receipt of a shipment real-time.

To eliminate privacy concerns, the drugs were packaged in bulk units specifically for the pharmacy. At the time of filling a prescription, the pharmacist would provide patient with drugs in an individual prescription bottle.

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[169] Devices & Surgical Technology Week, "Medical Device; Healthcare services support FDA policy on radio frequency identification," December 26, 2004, 250.

To complete the process of completing an electronic pedigree, it later teamed up with Purdue Pharma, a major pharmaceutical manufacturer, to continue its pilot study of RFID technology.

5. Purdue Pharma

Purdue Pharma quickly met some challenges during its pilot study. It became aware, that at the time of testing, its RFID tag vendor had limited capabilities. At that time Matrics did not have the capability to embed the RFID tag into the pharmaceutical label which caused Purdue Pharma to seek that capability elsewhere. It found a label maker called Guilford Gravure. Guilford Gravure not only had the embedding capability, but also the ability to incorporate added anti-counterfeiting characteristics. Purdue Pharma had Matrics and Guilford Gravure work together to produce a quality RFID embedded label for them. Achieving this milestone took quite a bit of work. Both Matrics and Guilford Gravure had to expand its inspection process of the RFID embedded label prior to shipment to Purdue Pharma to significantly increase the readability rate.

Purdue Pharma had to include extra measures to ensure the RFID embedded label could not be easily damaged, withstand extreme temperature changes, repeated drops and more during the shipment of drugs to its customers.

Purdue Pharma also had to ensure that the right EPC was matched with the right strength of a specific drug and to ensure no EPCs were duplicated. It worked very closely with Matrics to develop and refine a system that would reject a bottle that had either a duplicate EPC or was labeled with conflicting EPC and strength information.

In June 2005, H. D. Smith announced that the electronic pedigree tracking pilot study would be tested with Purdue Pharma's infamous drug, OxyContin in July 2005. To date, the results of this test have not been published.

H. D. Smith completed its pilot study with Purdue Pharma using an Ultra High Frequency (UHF) 915 MHz RFID system. In the future, it plans to complete a pilot study with Pfizer, another major drug manufacturer, using a High Frequency (HF) 13.56 MHz

RFID system. Although the cost of these pilot studies are expensive and time consuming, H. D. Smith believes that they will reap many benefits in the end.

B. CONSULTATION

Adopting a new technology into an organization's current business practices can be very challenging and costly. Unless you happen to be highly current and connected with the industry that supplies technology, you are probably limited to relying on suppliers, internal committees, or your own departmental "experts" for advice. Each one of these has their shortcomings:

A supplier's number one goal is to sell you a product. This may not necessarily meet the business application needs of your organization. It must be remembered that the advice given by the seller will most likely be self-serving, meeting the needs of the supplier.

Internal committees come with their own agendas and preconceptions. They know your agency, but they may not know all there is to know about the industry. Input from employees is critical, but it shouldn't be the only voice. Sound implementation should be as a result of many voices.

The information technology department "expert" will more than likely be the person that knows more about the technology than anyone else in the organization. The level of expertise can vary. Also, the area of expertise will most likely be focused on a particular segment of the industry, depending on the requirements of the organization. However, internal experts may not have resources or time to keep abreast of a quickly evolving technology, such as RFID technology.

Many may ask what some of the benefits of hiring a consultant are. A few benefits are independence, fresh perspective, and an updated knowledge of RFID technology. Having a consultant can help an organization think outside the box. Thinking outside the box can mean the difference between throwing money away to keep up with the latest technology or investing in new technology wisely. Of course, working with a supplier, establishing internal committees, and calling on the information

technology department are important. These different voices must be heard to determine the actual need and capabilities required by the organization. They can assist in mapping out the best possible application to meet organizational requirements. The implementation of RFID technology could mean a complete business system/process overhaul or an integrated business system/process. The actual path chosen depends on the organizational needs and the current capabilities of RFID technology.

Having an independent consultant may help an organization determine that system integration is the key; not ripping out the old system and establishing a new RFID system. A consultant can independently examine an organization's business processes and outline possible uses for RFID, both now and in the future. The final document can give detailed cost estimates, which is especially important to small to medium size businesses that don't have a well-padded IT budget.[170]

Consultants can assist in investing wisely in a new technology through systems integration. Integration among RFID systems, warehouse-management systems, and ERP applications is probably the most difficult aspect of RFID implementations, though such integration can yield greater supply chain visibility and other benefits. Some believe that this will determine the winners and the losers. Software integration is very complex and requires more than a slap-and-ship approach. System integrators or consultants can help overcome the challenges without completely ripping out the old system and replacing it with the new.[171]

1. Massachusetts General Hospital (MGH)

MGH is well known for hiring the best and brightest employees. As such, MGH has decided not to seek assistance from an independent consultant. MGH believes that it's important for those determining the many applications of RFID technology to understand the day-to-day operations of the hospital and particularly understand the

[170] Laurie Sullivan, "RFID Help from the Outside," Information Week, March 28, 2005, http://www.informationweek.com/showArticle.jhtml;jsessionid=RDEUUDVLFDN0IQSNDBCSKH0CJUMEKJVN?articleID=159905595, October 2005.

[171] Laurie Sullivan, "RFID Help from the Outside," Information Week, March 28, 2005, http://www.informationweek.com/showArticle.jhtml;jsessionid=RDEUUDVLFDN0IQSNDBCSKH0CJUMEKJVN?articleID=159905595, October 2005.

function of the department in which application is being considered. An independent consultant would not inherently have the internal operational understanding required to map out the best way to implement RFID technology into its current business processes. The independent consultant would have to be briefed on these internal operations as quickly as possible. The lack of complete understanding of the day-to-day operations could be viewed as a stumbling block in determining the best strategy for deploying a pilot study.

2. Jacobi Medical Center

Jacobi Medical Center chose Siemens Business Services as its system integrator. Siemens assisted Jacobi in designing, deploying, and managing a pilot RFID system that replaced a heavily manual system that issues patients an identification wristband. The trial RFID system also sought to replace manual procedures for updating a patient's medical records. With Siemens assistance, Jacobi was able to see a number of benefits, including cost and time savings after only two months of testing.

3. McKesson

As pointed out in the case study for McKesson, Accenture led the industry-wide RFID technology initiative called JumpStart. Accenture is an independent organization that specializes in consultation, technology, and outsourcing solutions packages. One of Accenture's roles in the initiative was to define the value drivers of the technology. Accenture also created a solution designed to establish whether EPC/RFID has the potential to increase the safety and security of the supply chain while improving operational efficiency, recalls, and returns management processes. The Accenture led JumpStart initiative gave each participant an opportunity to collaborate with trading partners throughout the supply chain. The shared efforts allowed issues to be resolved more quickly than if each organization had completed an independent pilot study. The collaboration also allowed the resolutions to be easily and quickly tested throughout the entire supply chain. Some of the key benefits that the group immediately saw were greater visibility of inventory location at all times and reduced patient wait time through quicker prescription processing at the pharmacy. The group was also able to see that RFID technology is not ready to go "prime time" in the pharmaceutical industry. There

remain challenges to achieve high performance of the technology as the pharmaceutical industry strives to increase security and efficiency.

4. H. D. Smith and Purdue Pharma

H. D. Smith chose Matrics (now Symbol Technologies, Inc.) to assist in mapping out the business case for RFID technology, create new processes, stick to a budget, and determine the goals and objectives, such as what drugs to begin tagging first. Franwell was chosen as the systems integrator to develop a combined bar code and RFID tag. H. D. Smith stated that one of the benefits of working with a consulting company was close examination of what's needed now and what's possibly needed in the future. As most small to medium size businesses don't have the revenue to completely overhaul its information system, a consultant/integrator can offer ways to integrate RFID technology into its current business systems.

When H. D. Smith and Purdue Pharma teamed up to complete the electronic pedigree pilot study, they selected Unisys Corporation and SupplyScape to lead the pilot study. Unisys Corporation is a company globally known for information technology services and solutions. SupplyScape is a leader in defining a universal standards-based electronic pedigree solution for the pharmaceutical industry.

C. CULTURE

Culture is comprised of the values, behaviors, and norms of the members of an organization. In essence, culture is the personality of an organization. Just as we recall a person's history of actions, view their external appearance, and recall what they may brag about to get a feeling about an individual's culture or personality, we do the same to determine an organizations culture.

1. Massachusetts General Hospital (MGH)

Since its inception in 1811, MGH has made huge investments in research and development to promote innovation. As mentioned in the case study, it has conducted the largest hospital-based research program in the United States, with an annual research budget of more than $450 million. It is the oldest teaching hospital of Harvard Medical

School. In 2004, it was recognized as one of America's best hospitals by U.S. News and World Report for the fifteenth year. MGH has a tradition of being on the cutting edge of technology by pioneering new clinical procedures and technologies to provide world-class patient healthcare. A few of MGH's technology developments are as follows:

1896 The first X-ray image in the U.S. is made by MGH physician just 30 days after the technique is discovered in Europe.

1979 MGH radiologists pioneer use of magnetic resonance imaging (MRI) to diagnose illness and injury.

1991 Researcher at MGH nuclear magnetic resonance (NMR) center are the first to develop high-speed MRI scanning.

Although, MGH is a leader in innovation, it is taking its time to learn the technology. We believe that organizations with a strong cultural background and reputation for being a leader, tend to be more risk averse than their smaller counterparts in their respective industries. MGH is taking their time to learn more about RFID technology to see whether they can make a business case argument for it. By experimenting with the technology (pilot studies) and seeing first-hand the advantages and disadvantages, they will be able to make an informed decision, while simultaneously gaining buy-in of their numerous stakeholders.

2. Jacobi Medical Center

Founded in 1955, Jacobi has developed a reputation for innovation. It's surgeons performed the first coronary bypass in 1961. It also pioneered the use of bedside minicomputers to monitor blood circulation and lung function. According to Daniel Morreale, former CIO for North Bronx Healthcare Network, Jacobi is very pro-technology and has been for about 15 years. When Jacobi began to consider RFID technology to improve patient care and increase efficiency, in its operations, it became another in the long line of technologies to test and then implement. Currently, Jacobi operates on a completely computerized physician order-entry system, allowing a range of doctor request to take place electronically. Additionally, around 95 percent of the hospitals health records are managed electronically. This is a major milestone that DoD's

healthcare system is currently striving towards. Jacobi has developed a culture of continually searching for possible ways to incorporate the latest technology into its processes, making them more efficient.

After only a two month trial period of RFID technology to improve patient care and increase efficiency, Jacobi immediately adopted the application into its processes and plans to expand the application in other areas of the medical center. Jacobi estimates it will save about $1 million each year using RFID.

3. McKesson

In 1969, McKesson became a vanguard of information technology with the innovation of Economost, a computer ordering entry system. Knowing the value of information technology to improve operational processes, in 1999, McKesson merged with the largest healthcare information technology business, HBO & Company. Today, McKesson's motto is "Empowering Healthcare." For over 170 years, its hallmark has been service and innovation. It has the culture of empowering not only its employees, but also its customers with innovative thinking and technology. Not only does McKesson distribute pharmaceuticals to retailers, it also offers its customers a variety of Automated Prescription Systems (APS). McKesson has been the leader in pharmacy automation since the introduction of the Baker Cells in the early 1970s. McKesson understands that the automation market is constantly changing. McKesson's history reflects its constant culture of being the leader in research and development to meet the changing needs of its customers.[172]

Gaining stakeholder buy-in is critical in any organization, but the larger you get, the more complicated it is, especially if it is a publicly held company (e.g. McKesson). It is difficult for market leaders to quickly adopt any changes, without first introducing the new technology, process, etc., testing it to make sure it works, and then demonstrating to its many stakeholders how it will benefit them, the company, customers and so on. By doing this, organizations gain their stakeholders' trust (buy-in) and thus less resistance to change when implementing the new technology or process.

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[172] McKesson, Automated Prescription Systems, http://www.mckessonaps.com/wt/aps/home, November 2005.

4. H. D. Smith

It's been said that an organization's history shapes its future. H. D. Smith continually seeks for ways to manifest its vision of with new programs, new markets, and ever-improving services. H. D. Smith's motto is "Excellence in wholesale drug distribution." It has developed a culture of continually developing solutions to increase efficiency and exceed customer expectations. That's why in June 2004, H. D. Smith decided to transform its bar code record keeping process into a high tech automated process through RFID technology. This transformation has proven to be a bold and significant investment decision. H. D. Smith has pretty much adopted the technology because of the potential benefits it offered. Although, it is currently experiencing negative returns on its RFID investment because of narrow margins, it believes that the cost is worth the customer service benefit.

D. STANDARDIZATION

Standardization is often abbreviated as (s13n). It is defined as setting technical norms or uniform criterion among competing entities in a market by offering industry-wide benefits, such as improving efficiency, without diluting competition. It is also viewed as a tool for optimizing economic use of a particular resource, such as a scarce resource. The standards are usually developed in a voluntary consensus standards group, such as EPCglobal and Healthcare Distribution Management Association (HDMA).[173]

Standards are often viewed as de facto, meaning they are adhered to for simple convenience. We favor the military context, given by Wikipedia, where it says that, "standardization as the establishment and implementation of concepts, doctrines, procedures, and designs to achieve and maintain the optimal level of compatibility, interchangeability, or commonality in an operational, procedural, material, technical, and administrative area to attain interoperability."[174]

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[173] Wikipedia Encyclopedia, "Standardization," http://en.wikipedia.org/wiki/Standardization, November 2005.

[174] Ibid.

Massachusetts General Hospital, Jacobi, McKesson and H. D. Smith

A major underlying pattern observed from the case studies was the lack of industry standards and interoperability among the various RFID vendors. Pharmaceutical manufacturers, distributors and retailers, along with healthcare executives and practitioners will have to work together to set industry standards that will facilitate the use of RFID to improve the efficiency, visibility, and quality of the prescription drug supply chain. It will be especially important for patients and consumers to be made aware of the ongoing progress in the use of RFID in the drug supply chain. Good public relations and education will be key, so that accurate information is disseminated to the end users and the inevitable fear that "Big Brother is watching" can be put to rest.

Of the four organizations we studied for this project, McKesson appeared to be the most actively involved in groups focused on establishing standards for RFID technology. One of the groups is EPCglobal, a leader in focusing on developing industry-driven standards for EPC to support the use of RFID technology.[175] Ron Bone, of McKesson, strongly supports EPCglobal's vision and is actively involved in setting standards for the industry.

Here's what Dr. Jean-Pierre Garnier, CEO of pharmaceutical maker GlaxoSmithKline PLC in London, had to say about interoperability and standardization. He stated that his company's "long-term goal is the development of an electronic product code that will help track, trace and authenticate medicines through the whole distribution system." He added, though, that the RFID initiative "is a daunting technological task that could take at least three to five years." Garnier said one of the biggest hurdles faced by companies that want to install RFID-based systems is the need to agree on industry standards and a common IT infrastructure so medicines can be tracked across the entire supply chain.[176]

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[175] EPCglobal Inc., Welcome to EPCglobal Inc.," http://www.epcglobalinc.org, November 2005.

[176] Computer World, "FDA Backs RFID Tags for Tracking Prescription Drugs," http://www.computerworld.com/mobiletopics/mobile/technology/story/0,10801,90368,00.html, November 2005.

EPCglobal is a non-profit organization that's leading the drive to establish industry standards for the EPC to support the use of RFID technology. The organization focuses on creating global standards to increase visibility and efficiency in the supply chain management industry. EPCglobal promotes high quality information sharing between organizations and its key partners in the supply chain.[177]

E. CHALLENGES

1. Cost

Cost remains to be a major challenge for the implementation of RFID technology not only in the pharmaceutical industry, but in all industries. The cost, which could range from $100 to $3000 and more, of an RFID reader depends on the frequency and the readability range. The hospital, a warehouse, or a manufacturing facility would probably need up to thousands of readers to ensure tags are read efficiently and quickly. The cost of the tag is relatively high. At the time of our literature review, the average cost of a tag was .50 cents. Today, the average cost ranges from .25 to .35 cents per tag. At the current cost of the tag, reader, and middleware, fully implementation can be extremely high for an organization. Experts believe that the cost of the tag needs to be driven down to .05 cents per tag. In order to reduce the cost per tag, more wide-spread adoption must take place. Thus far, we've only mentioned two cost aspects, but there are many more. To name a few are: printers, middleware, infrastructure, consulting, research and development, system changes or integrations, training, and possibly change management. Early adopters will see the height of the cost due to the fact that there are no best business practices currently in place and many will learn from costly mistakes.[178]

2. Disproportionate Investments and Benefits

The industries with thin margins, such as a pharmaceutical wholesale distributor, will more than likely lose money in the beginning phases of implementing RFID

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[177] EPCglobal Inc., Welcome to EPCglobal., Inc., http://www.epcglobalinc.org/index.html, November 2005.

[178] Larry Shutzberg, "Early Adopters Should Be Wary of RFID Costs," Information Week, November 1, 2004, 98.

technology. Unless the organization can easily pass the cost of the system on to the customer, they will have to bear the reduced margins for a while. This is especially true when an industry shifts from case-level tagging to item-level tagging.[179]

Being a first mover is very risky and costly, and initially it will more than likely have a negative impact on productivity and revenue for both a large and small organization. It is predicted that a large organization will see a reduction in profitability. It is also predicted that many smaller organizations will lack the capital to remain as an early player. To get a competitive edge, however, it is very beneficial for a small organization, such as H. D. Smith, to take the risk and be an early, aggressive innovator. In order to be successful, the leader of the small organization must be a true visionary, clearly communicating the vision by making it very plain, and have a strong core group to guide the process change. The organization should also have a willingness to develop a partnership and have reliable sources to carryout the vision.[180]

The Harvard Business School offers six steps to guide an organization in developing a plan as an early adopter of RFID technology. They are as follows:[181]

Get familiar with the technology – learn the benefits and the challenges.

Choose the right scenario – determine what information is critical, e.g., serial number, expiration date, batch number, manufactured date, etc.

Secure RFID resources – begin the negotiation for tag, reader, etc. production.

Prepare financially – quantify operational and capital investment cost.

Evaluate your organization's structure – modify management structure and rewrite job descriptions at the lowest level possible.

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[179] Jonathan Byrnes, "Who Will Profit from Auto-ID?," Harvard Business School, September 1, 2003, http://workingknowledge.hbs.edu/item.jhtml?id=3651&t=dispatch, November 2005.

[180] Ibid.

[181] Ibid.

Create a customer roll-out plan – develop appropriate plans for different accounts/activities. Build a explicit joint plan to resolve legitimate concerns, such as privacy.

3. Health/Privacy/Security

Unlike bar codes requiring a clear line of sight to be read, RFID does not. The radio frequency freely travels through the airwaves not requiring a line of sight to communicate. When a microwave oven is in use, more than likely there are notifications posted in its immediate vicinity. Radio frequency waves are everywhere, not confined to a particular space. Consumer advocacy groups have expressed concerns of not having a choice of knowing when and where the technology is actually being used. Consumers ask, "What are the health impacts of these waves being everywhere? Is this technology conducive for living in a safe environment?[182]

There are also privacy concerns. Consumers want to know, "Are there measures in place to reduce or eliminate possibility of abuse and invasion of privacy?" There are also concerns about shifts in employment. We clearly see that one of the benefits of RFID is reduced labor cost for the organization. That equates to job elimination or modification. In many cases, more technical training may be required. This could be a difficult transition for some groups of people, such as baby boomers. Some may not have the confidence or stamina to make the transition, and find themselves retiring early or searching for new employment.

According to Blubaugh and many others, security is an issue when it comes to the possibility of a firm's business information line being tapped into by a competitor through the use of RFID technology.[183] Also, many privacy advocacy groups argue that anyone with an RFID reader can access personal data of a patient. Sanchez et al. agree that the advocacy groups have a valid concern. Sanchez et al. and many others argue that like any new technology, there will always be a give-and-take between legitimate uses

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[182] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 7.

[183] Marc Blubaugh, "RFID Becoming Standard Whether Firms Like It or Not," Columbus Business First, (2004): par 10, http://www.bizjournals.com/columbus/stories/2004/10/04/focus8.html, November 2005.

that benefit consumers and potential abuses. They also stated that RFID manufacturers are currently looking at possible advancements that will enhance security and eliminate these concerns. Sanchez et al. continue to stress that RFID utilization offers medical treatment facilities (MTFs) the ability to quickly and accurately collect needed patient data and improve processes that increases patient safety and patient satisfaction.[184]

Another aspect is that unless the data transmitted by the RFID tag is considered in context, it will not be meaningful to the intruder. The possibility of security threat emerges when location-based or personal information is connected to the data encoded on the RFID tag.[185] That's why H. D. Smith pointed out in its pilot study that the tag would be placed on bulk unit bottles to be distributed only to the pharmacy. Prescriptions would be filled by the pharmacist from these bulk units. An RFID tag would not be attached to the consumer's individual prescription bottle.

4. Information Sharing

Competitive advantage remains a major key to success for an organization. Many organizations have become market leaders because they implemented a critical process or system that its competitor knew nothing about early on. Now they are reaping the benefits of that early adoption or knowledge gained through lots of research.

Although RFID technology is old, some of the applications for which many organizations are considering are new. The new applications pose a major challenge in its implementation. A key reason for this challenge is a lack of standards. Of course, to develop standards in an industry there must be collaboration about data. Some data may be proprietary information, such a sales volume and shipment frequency. Organizations see sharing this information as a threat to their competitive advantage. This is exactly the case in the pharmaceutical industry. The industry wants to create an electronic pedigree of drugs being transported through its supply chain. This requires the ability to capture information and share it amongst the manufacturer, wholesaler/distributor, and retailer.

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[184] Joaquin A. Sanchez et al., "Medical Equipment Through the Use of Radio Frequency Identification (RFID)," (MBA thesis, Naval Postgraduate School, 2004), 52-3.

[185] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 7.

Many in the industry find it difficult to trust others in the supply chain with its proprietary information.

5. Physical/Environment

As mentioned in our literature review, water (to include cold storage) and metal can cause interference in the interrogator being able to read an RFID tag. The pharmaceutical industry and others similar to it, such as the food/produce industry, are posed with additional physical and environmental challenges. The pharmaceutical industry is highly sensitive and regulated by very strict guidelines. Some of the physical and environmental challenges met by the pharmaceutical industry are extremes in temperature change, packaging constraints, labeling standards, and the interactions between product and RFID signals.[186]

As mentioned in the case study for H. D. Smith, Purdue Pharma, one of its partners during its phase-in pilot study, had to search for a label maker that had the capability to embed the RFID chip into the product label. It was important that this label would have a high readability rate and would be in compliance with FDA and other government agencies' guidelines. Recently, an evaluation of the effects of RF waves on in a temperature sensitive liquid pharmaceutical, such as insulin was completed. It was found that exposure of the RFID tagged vial of insulin in a well insulated box would result in additional heating.[187] This could have an effect on the quality of the insulin or other liquid pharmaceutical, by the time it's infused in the patient.

6. Interoperability/Configurations/Standardization/Integration

One RFID tag manufacturer may use a frequency that's different from another RFID tag manufacturer. Due to the configurations being different, there is a lack of interoperability between the different systems. This could drive the cost of implementing RFID technology in an organization upward because the organization would have to purchase readers and middleware that's compatible with the frequency level of the tag.

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[186] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 8.

[187] Howard Bassen, "Liquid Pharmaceuticals and 915 MHz Radiofrequency Identification Systems, Worst-Case Heating and Induced Electric Field," (White Paper, U. S. Food and Drug Administration, 2005), 1.

Massachusetts Institute of Technology (MIT) developed an Electronic Product Code (EPC), which is considered a license plate for individual items. An EPC is similar to a bar code which reflects digits that identify the manufacturer, product, version, and serial number. The difference between the two is that an EPC uses a set of additional digits to uniquely identify an individual product.[188] EPCglobal is a non-profit organization that's leading the drive to establish industry standards for the EPC to support the use of RFID technology. The organization focuses on creating global standards to increase visibility and efficiency in the supply chain management industry. EPCglobal promotes high quality information sharing between organizations and its key partners in the supply chain.[189] Highly sensitive industries, such as the pharmaceutical industry, may require RFID technology to meet higher performance measures than that of a not so sensitive retail industry.

As mentioned earlier, integration among RFID systems, warehouse-management systems, and Enterprise Resource Planning (ERP) applications is probably the most difficult aspect of RFID implementations; though, such integration can yield greater supply chain visibility and other benefits at a somewhat reduced cost than ripping out the old and completely replacing with the new. Some believe that successful system integration will determine the winners and the losers. Software integration is very complex and requires more than a slap-and-ship or plug-and-play approach.

7. Data Storage and Management

The use of RFID technology creates a huge stream of high speed data flow. This high speed influx of data creates a new challenge for hardware and software vendors. Quite a bit of the data in the streamline is reiterated. Therefore, algorithms for filtering operations need to be established to eliminate repeated data, specific to the organization or industry.[190] During our interview with Massachusetts General Hospital (MGH), we

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[188] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 8.

[189] EPCglobal Inc., Welcome to EPCglobal., Inc., http://www.epcglobalinc.org/index.html, November 2005.

[190] Velan Thillairajah et al., "Realizing the Promise of RFID: Insights from Early Adopters and the Future Potential.," (White Paper, EAI Technologies, 2005), 8.

asked if network overload was a concern. Steve Spring, Operating Room Financial Officer of MGH, responded, "yes" and went on to say that funding and other measures are in place to ensure that MGH's network infrastructure remains robust enough to efficiently process the influx of data.[191]

[191] Kevin Gangadeen and Bernadette Houston, interview with Steve Spring of MGH, September 27, 2005.

X. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Passive RFID technology is "not ready for prime time" according to Dr. Sandberg and others at MGH. Using RFID technology in the pharmaceutical industry is still in its infancy. All of the organizations we researched for this project are still in the pilot study phases of their RFID implementation plans. From our research we discovered only one drug manufacturer (Purdue Pharma) has to date implemented RFID technology in its manufacturing processes. Other drug manufacturers are or will be doing their own pilot tests in the near future. In the pharmaceutical wholesale/distribution industry H.D. Smith made the leap into RFID technology as an early adopter, despite the cost. The hospital pharmacies we reviewed are currently using bar code technology. They have heard of RFID, but did not seem to have any plans, in place for the near future, to implement this new technology. Although many are very optimistic about the many potential benefits, there are still many challenges and limitations to overcome in order to apply RFID technology to its fullest potential.

What Does the Analysis Say?

Market leaders take the time to learn about new technologies before implementing throughout their organizations. They conduct experiments, pilot studies, and research to thoroughly understand the new technology/processes and determine how it may benefit their organization. In their research, they learn of past challenges that have been resolved and those challenges and concerns that remain. As leaders they have a reputation to maintain and to be concerned about. So, aggressively implementing new technologies without doing the homework could spell immediate disaster to their leadership status and legitimacy in their industry.

By using pilot studies, testing, and experimenting with the technology/processes with a limited number of people within the organization and identifying and working through the problems early on (cheaper than after full implementation), there is the opportunity to increase buy-in of the organization's leadership and staff. Once the new

technology proves itself on a small scale then the leadership can easily implement it organization-wide with less resistance. In other words, a more bottoms-up approach versus a top-down driven initiative.

For our project, we reviewed McKesson and H.D. Smith in the wholesale/distribution industry. McKesson, as the market leader, is taking the time to learn how they can exploit the benefits of RFID before implementing it throughout their entire organization. They have appointed an individual to serve as the RFID guru for the company, to learn all aspects of the technology (positive and negative), started a pilot study in one of their distribution centers to test it, and then based on their findings will decide whether to implement across the entire organization. As a publicly held company, they are also working with their various stakeholders to ensure they get "buy-in" before they decide to fully implement the technology.

H.D. Smith on the other hand chose to be the first to adopt the technology despite the cost. As the seventh largest wholesaler/distributor and a privately held company, they took the risk of being the first mover. The firm argues that while they are currently experiencing a negative return on their investment in RFID, they see the full potential benefits of the technology. They feel that they will be able to recoup their losses and even gain greater market share over the long term. H.D. Smith feels the investment in RFID is worth it for the customer service benefits it will bring, because ultimately, they believe implementing RFID is doing the right thing.

Being the first mover in an industry can have its advantages and disadvantages. The most obvious advantages are the ability to learn about the technology/processes first-hand (learn by doing), thus reducing the learning/experience curves and hopefully reducing unit costs (i.e. reducing variable costs (e.g. labor) and increasing fixed costs (e.g. automation). Another advantage to being a first mover is that it can bring attention to the a smaller supplier that the manufacturer or retailer might have missed in the past as being a company willing to step up to the plate when called on. The disadvantages of course would be the upfront costs that may be involved, the organization's culture (i.e. ability to accept change quickly), and most importantly, whether the new technology adds

value to the organization. Being the first mover is inherently more risky as there is no one else to learn from, benchmark, or imitate.

Another common pattern seen is that **market leaders hire people whom they believe to be the "best and brightest" to help them implement new technologies/processes.** These people may be internal (employees) to the organization (as in the case of MGH) or external (use of consultants.) These people become the "change catalysts" within the organizations by being vocal advocates of the new technology/processes they are endeavoring to put in place. The bottom line is ensuring that experts are heavily involved in the process development. The implementation of RFID technology could mean a complete business system/process overhaul or an integrated business system/process. The actual path chosen depends on the organizational needs and the current capabilities of RFID technology.

Market leaders encourage the spirit of entrepreneurship to thrive as part of their organizational cultures. Top leadership is involved by allowing monitored creativity and creating strong organizational cultures that are open to new ideas and not afraid of change. The author John P. Kotter, well known for many leadership books says that it's important to empower employees to try new technologies and ideas, and to provide leadership in change. Establishing a guiding coalition (as MGH and McKesson has done), encourages others to take action. Although it's very important to have senior executives support to implement a major change, the most powerful coalition groups must include key line managers and other staff members with information, expertise, reputation, and relationships. This type of multi-disciplined core presents a strong line leadership can take the power endowed upon them and achieve the goal of creating more buy-in, empowering others, and maintaining credibility as the organization pursues its efforts.[192]

Market leaders focus on the global picture and collaborate to develop standards. In order for each organization in the supply chain to reap its fair share of benefits, collaboration must take place to develop standards for RFID technology and its

[192] John P. Kotter, "Leading Change: Why Transformation Efforts Fail," Harvard Business Review, (1995): par 12-17 and 31-36.

many applications. Standardization may require the sharing of proprietary information, such a sales volume and shipment frequency. The JumpStart project, which McKesson participated in, clearly demonstrated the power of collaboration and partnership. The shared efforts of the project allowed issues to be resolved more quickly than if each organization had completed an independent pilot study. The collaboration also allowed the resolutions to be easily and quickly tested throughout the entire supply chain.

Market leaders tend not to be imitators when implementing new technology/processes. They take the time to learn about the new technology/processes, experiment with it themselves to see if meets their requirements, and if it does, implement it organization-wide. Wal-Mart not only implemented organization-wide, but also externally, by mandating their top suppliers do so as well.

Wal-Mart created a research facility at the University of Arkansas to test and develop RFID technology before mandating its 100 top suppliers implement the technology the beginning of 2005. Since then Wal-Mart conducted a 29-week study to analyze out-of-stock merchandise at 12 stores equipped with RFID and 12 stores without RFID technology. According to Wal-Mart, the study was independently conducted by researchers from its home town University of Arkansas. Wal-Mart reports its out-of-stock items were replenished with RFID three-times faster than with the old bar code technology. For Wal-Mart, which is always looking to squeeze the last dime out of any of its operations, the change in technology could transfer into a still undisclosed savings.[193]

B. RECOMMENDATIONS

Based on our analysis and conclusions, here are some common patterns (best business practices, if you will) we observed of market leaders in the pharmaceutical wholesale/distribution and hospital industries in their initial testing of passive RFID technology. We believe that DoD should use the following information in its implementation of RFID technology.

[193] Bob Malone, "To RFID Or Not?," Forbes.com, http://www.forbes.com/2005/11/01/rfid-walmart-savings-cx_rm_1031rfid2.html?partner=weekly_newsletter, November 2005.

- Market leaders take the time to learn about new technologies before implementing throughout their organizations.
- Market leaders hire people whom they believe to be the "best and brightest" to help them implement new technologies/processes.
- Market leaders encourage the spirit of entrepreneurship to thrive as part of their organizational cultures.
- Market leaders focus on the global picture and collaborate to develop standards.
- Market leaders tend not to be imitators when implementing new technology/processes.

The implementation of RFID technology can be quite costly, even at the pilot level. A successful implementation requires appropriate time and resource allocation and a solid leadership to see the implementation all the way through. If implementation of RFID technology is not properly managed, it could be disruptive in current business processes and have a negative impact on operations. Therefore, after learning the technology, partnering with the "best" to implement, encouraging a monitored spirit of entrepreneurship, and collaborating to develop standards, we believe that it would be wise for DoD to tailor RFID technology for applications in which it feasibly fits and increases efficiency and patient safety.

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