Sense and Respond Supply Chain: A Prescription for Mitigating Vulnerability in the U.S. Pharmaceutical Value Chain

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ABSTRACT

Faced with a rising tide of counterfeit drugs, U.S. pharmaceutical firms must turn to S&R supply chain to better track and trace prescription drugs. Today's global PVC networks are more than ever exposed to great risk/vulnerability due outsourcing, counterfeit and drug diversion, and parallel trade. Pharmaceutical executives are now recognizing the cold reality that the inability to S&R to disruptions in the prescription drugs supply chain can hamper patient safety, public health confidence, brand image, corporate earnings and shareholders' value. Those pharmaceutical firms able to S&R to risks of counterfeit and drug diversion will gain public health confidence and strategic competitive advantage. Those firms that ignore the S&R supply chain imperative do so at their own peril. For firms, survival of the fittest in today's challenging business environment is indeed predicated on the ability to adapt and respond to vulnerabilities and disruptions. The ability to sense vulnerabilities and provide near perfect real-time information to adapt supply chain processes is imperative. And the key enabler to S&R supply chain is RFID technology that has been touted as the "holy grail". Because of the significant promise that RFID has, FDA recommended its adoption by the pharmaceutical industry in order to achieve and meet the electronic pedigree requirement and compliance.

Introduction

Succeeding in today's ultra-competitive environment requires agile and adaptable value chain networks that are ready to sense and respond (S&R) in real-time to a changing global business environment. Although a significant number of industries have embraced S&R supply chain model to respond with agility to opportunity and threat, the pharmaceutical industry is yet to adopt the model as an additional multi-layered approach agains counterfeit drugs in the U.S. pharmaceutical value chain (PVC) networks. The U.S. PVC networks have become more vulnerable to counterfeiting than was the case in the past. For example, the practice of legal parallel trade and outsourcing has exacerbated the PVC vulnerability to counterfeits and diversion. Pharmaceutical diversion entails procuring drugs in one channel of distribution and selling it to another channel at a premium price. These diversion channels that violate contract and laws are often used to introduce counterfeit pharmaceuticals. Such transactions tend to offer a great opportunity for counterfeiting. Hence the longer the PVC is, the greater the vulnerability to counterfeiting.

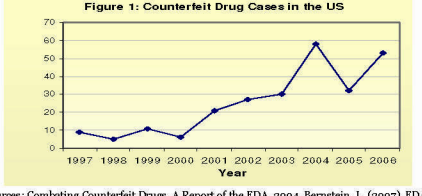
Drug counterfeiting is a critical issue confronting the global pharmaceutical industry, health providers, patients, and governments worldwide. According to the World Health Organization (WHO), a counterfeit medicine is one that is "deliberately and fraudulently mislabeled with respect to identity and/or source. Counterfeiting can apply to both branded and generic products and counterfeit medicines may include products with the correct ingredients but fake packaging, with the wrong ingredients, without active ingredients or with insufficient active ingredients." For more than two decades, counterfeit drugs were thought to be a problem only in developing nations and so received little or no attention to curb such nefarious activities that have continued to kill a large number of people in developing countries. Although counterfeit or otherwise substandard drugs are prevalent in both developing and developed countries, the U.S. has not witnessed a similar proliferation due to the tight regulatory protocols in existence. However, in the past few years, the number of

counterfeit drugs flowing into the U.S.'s legitimate supply chain has been growing steadily. This spate in counterfeit drugs in the U.S. PVC has led to serious concern among supply chain stakeholders – pharmaceutical manufacturers, wholesale distributors, end-users/patients, state regulatory agencies, and the FDA. They are concerned because counterfeit drugs can lead to disease resistance and can kill unsuspecting consumers en mass. Protecting and securing PVC networks demands constant vigilance in collaboration with all the supply chain stakeholders, including the manufacturers, the primary wholesaler distributors, pharmacies, state and federal legislators and regulatory agencies (Zimmerman, 2006). Although there is no one best approach that can protect and secure the PVC, the pharmaceutical industry needs to adopt a multilayered approach (Enyinda and Tolliver, 2007) and most importantly a S&R supply chain to mitigate and manage the PVC vulnerabilities. Zimmerman (2006) contends that the best strategy to secure and ensure product integrity and patient safety is through the primary or normal distribution system. Primary distribution entails the movement of pharmaceutical products from the manufacturer to the wholesale distributor to the pharmacy.

The paper examines the prevalence of global value chain drug counterfeit and PVC vulnerabilities. Specifically, the paper proposes leveraging S&R supply chain model to thwart the prevalence of counterfeit drugs in the U.S. PVC. This paper should assist the pharmaceutical industry, governments, international health community, and health policy makers in their efforts to streamline and improve the safety and integrity of pharmaceuticals.

Global Supply Chain Drug Counterfeit Prevalence

The prevalence of pharmaceutical counterfeiting looms as a major threat to the already ailing and debilitated U.S. healthcare supply chain. Pharmaceutical counterfeits can impose tremendous costs on both the pharmaceutical industry and patient safety. The costs through the actions of counterfeiters and diverters include more sick patients, loss of life, erosion of public health confidence, loss of brand image, reduced profit and reduced shareholder value. These costs are compounded by the costs of product recalls and the growing threat of counterfeiting and diversion. Compromised or untrustworthy drug value chains can create uncertainty, decrease investment, and decrease in research and development. Further, increased uncertainty and risk perceptions can hamper investors' confidence thereby discouraging them from investing their capital in new drug research and development. Although the claim is that the U.S. drug value chain is among the safest and secure in the world, counterfeit drug cases in the U.S. (see figure 1) are increasing steadily due to growing threats from technological savvy drug counterfeiters. Counterfeiters sell counterfeit drugs to unsuspecting patients at high risk, by exposing them to unknown contaminants and thus denying them medicines known to be safe and effective at treating their medical ailments (Lutter, 2006).



Sources: Combating Counterfeit Drugs, A Report of the FDA, 2004. Bernstein, L. (2007). FDA's Counterfeit Drug Initiatives and RFID. http://www.actgov.org.actiac/documents/pdf/IlisaBernstein.pdf.

The FDA believes that counterfeiting is not widespread within the system of manufacturing and distributing pharmaceuticals legally in the United States as a result of an extensive system of federal and state regulatory oversight and steps to prevent counterfeiting undertaken by drug manufacturers, distributors, and pharmacies. However, the agency has recently seen an increase in counterfeiting activities as well as increased sophistication in the methods used to introduce finished dosage form counterfeits into the otherwise legitimate U.S. drug distribution system. FDA counterfeit drug investigations have increased to over 20 per year since 2000, after averaging only 5 per year through the late 1990's. To ensure safety and security of the U. S. PCS, attention must be paid to the existing technology, business practices, legislation, regulation, public awareness and education, creation of an alert network, and international cooperation (FDA, 2004).

Pharmaceutical Value Chain Vulnerability

Supply chain vulnerability and disruption risks have been gaining increasing attention in the popular press (Peck, 2006, Kleindorfer and Saad, 2005, Christopher and Lee, 2004). PVC networks are vulnerable to counterfeit risk because of greater uncertainties in supply and demand, outsourcing, convoluted distribution channel, and advancement in technology. Also, it is vulnerable to counterfeit risk because the pharmaceutical firms not only purchase their raw materials or ingredients and manufacturing from dispersed low cost destination, but also they must depend on foreign contractors to coordinate the manufacture and distribution of their drugs. In essence, raw materials can be procured from one low-cost country, active ingredients produced in the second country, the final product produced in the third country, and packaging completed in the fourth country. Supply chain risk is any factor that can impact the reliability and continuity of supply of a commodity and/or service. The need to protect the public health by securing the US PVC has become imperative more than ever because counterfeit and fake drugs kill in large numbers. The consequences of counterfeit and fake drugs in the legitimate supply chain include endangering the lives of and well-being of patients, undermining the confidence of the medical profession in quality, safety, and efficiency of the products they prescribe, erosion of public trust and reduction in investment in the pharmaceutical industry, and undermining the reputation of firms whose products are counterfeited, through loss of both revenue and confidence (FDA, 2003).

The U.S. PVC has become more vulnerable to counterfeiting because of advancement in technology, increasing numbers of small distributors, growing use of the Internet and spate in prices of premium drugs (Bright, 2004). These drivers and others in both developing and developed nations have exposed the cold reality that global PSC networks are not safe and secure. Whereas the supply chain network in the past was mainly performed in a limited geographical area, the various elements of pharmaceutical production are now increasingly being outsourced to low cost destinations. This means that raw materials may be sourced in one country, active ingredients produced in another country and the finished products manufactured in a third country, with packaging being done in a fourth. These multiple processes expose the entire extended industry supply chain to counterfeits. Normally, drug manufacturers deliver pharmaceuticals to wholesale distributors, who in turn deliver them to pharmacy retail outlets and/or hospitals. However, in today's global pharmaceutical commerce, that is not the case. The primary wholesale distributors may sell drugs to secondary wholesale distributors or to re-packagers, and the secondary wholesale distributors can also sell to re-packagers and to pharmacies as shown in Figure 2.

The Primary distribution channel represents the normal process for distribution of product from the manufacturer to the provider or end user. The secondary distribution channel is the movement of products purchased from an authorized distributor, or source other than the manufacturer, to another intermediary. These products are then sold to the healthcare provider or the end user. The secondary distribution channel represents one method for the infiltration of counterfeit or otherwise adulterated drugs into the legitimate pharmaceutical supply chain. Within the secondary distribution channel, drugs often change hands many times before reaching the provider or the end user. These

multiple transactions can go back and forth before reaching the dispensing point. These chains of transactions often render the supply chain vulnerable to counterfeit drugs. In addition, counterfeit medicines can easily enter the legitimate medicine supply chain if the seller intentionally hides the medicines' original source from unsuspecting consumers by not providing a pedigree or even worse, providing consumers with counterfeit pedigree (Rudolf and Bernstein, 2004).

The point in the supply chain that is most vulnerable to counterfeit drugs infiltrating the distribution system is through the secondary wholesale distributors (Spies and Dusen, 2003, Patton, 2006). Both the legitimate and illegitimate pharmaceuticals regularly pass through numerous many stakeholders within and between supply chains before reaching the pharmacy retail outlets. Thus, the more medicines change hands, the greater opportunity for counterfeit drugs to be injected into the legitimate supply chain (Patton, 2006).

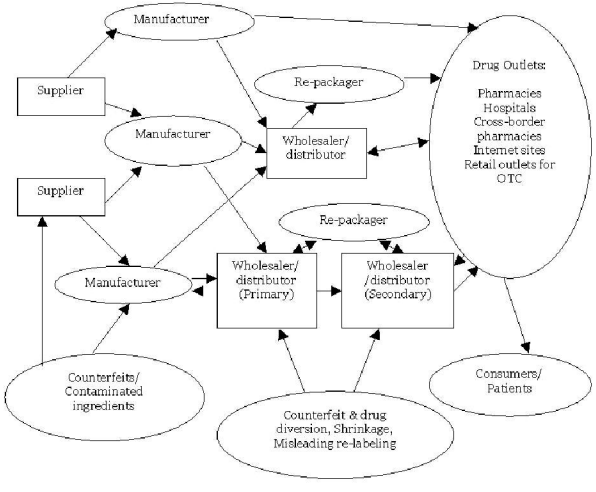


Figure 2: Convoluted Pharmaceutical Supply Chain Pathways for Counterfeit Risk
Source: Enyinda, C. I. and Szmerekovsky. (2007). In the IABPAD Proceedings, pp. 1056-1070.

Pharmaceutical Supply Chain Disruption and Pedigree

Pharmaceutical supply chain threats are shown in Figure 3. Panel 1 represents the normal drug flow starting from raw material source to drug manufacturing and to drug final destination. Panel 2 is disruption or interruption to the availability (permanence or non-adulterated) of legitimate drugs. Panel 3 represents diversion or interception of legitimate drugs. For modification in panel 4 is any action that compromises drug integrity (product has not been altered). Finally, fabrication in panel 5 represents any action that compromises drug authenticity (who produced or sent the product). The FDA and the U.S. pharmaceutical industry's mission critical must be to prevent both local and foreign healthcare terrorists (counterfeiters) from compromising drug supply chains. That means not only safeguarding drug supply chains at home, at physical borders and at ports of entry, but also globally in collaboration with the international health community. Safeguarding the U.S. healthcare systems against the threat of counterfeiters and diverters and ensuring the global PSC requires multilayered mitigation measures. Methods of defense or multilayered mitigation measures against counterfeiting and diversion that have been widely recommended include the traditional measures (e.g., holograms, overt and covert techniques, harsh criminal penalties and steep fines), supply chain electronic pedigree, radio frequency identification (RFID) technology-enabled tracking and tracing, and electronic pedigree.

A pedigree is a statement that traces all the transactions involving a product until it reaches the end user. Counterfeits or otherwise adulterated drugs can be mitigated from entering the legitimate supply chain by ensuring that manufacturers are in compliance with Good Manufacturing Practice (GMP) at the manufacturing point and by improving surveillance and vigilance by other authorized stakeholders. The FDA's counterfeit drug initiative has called for multilayered measures to deal with counterfeit drugs: securing the product/packaging, securing the movement of drugs throughout the supply chain, securing all business transactions, ensuring appropriate regulatory oversight and enforcement, increasing penalties, and increasing vigilance and awareness.

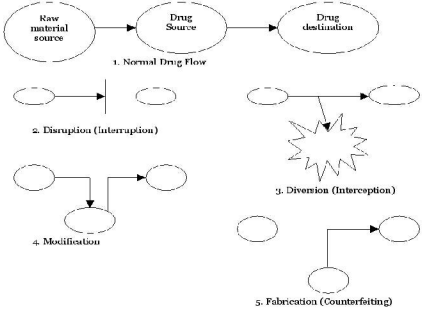


Figure 3: Pharmaceutical Value Chain Vulnerability
Source: Enyinda, C. I. and Szmerekovsky. (2007). In the IABPAD Proceedings, pp. 1056-1070.

The pharmaceutical chain of custody provides visibility into the movement, or custody of a product as it travels through the supply chain. As the product moves through the supply chain, a record of its location and ownership can be captured. Chain of custody allows companies to answer questions such as where is a product currently, where was it on a specific date, and most importantly for pharmaceutical security, that had access to the product at what points in time. This is important information in addressing complex supply chain issues such as product tampering, counterfeiting, diversion, and shrinkage. Product pedigree provides visibility into the composition of a product through all stages of manufacturing. As a finished product is packaged, information on its materials and components can be recorded, including the sources of those materials and components, to comprise the pedigree of the product. As the product moves through the supply chain, the manufacturer, trading partners and regulators all have access to the pedigree information. This information can be valuable in addressing issues such as defective or tainted ingredients, product recalls and product authentication. As an example, a recall may be triggered by a tainted component of a drug. The ability to track pedigree allows a manufacturer to determine not only which lots of the drug contained the tainted component but which specific units. Visibility into chain of custody helps the manufacturer identify the owners of the products subject to the recall, allowing only high risk products to be recalled, versus all products when only a portion of the goods are affected. Several states have already legislated pedigree laws as a combative measure.

Sense and Respond Supply Chain

Charles Darwin once said "it is [neither] the strongest of the species that survives, nor the most intelligent, but the one most responsive to change." Those organizations "that have been hugely successful...are great not because they were focused on cost or flexibility or speed, but because they have the ability to manage transitions, changing market [and environmental] conditions, evolving technology, and different requirements as a product moves through its life cycle. Organizations that can adapt are the ones that will be here for the long term" (Beth et al, 2003). Arguably, smart supply chains can create customer or shareholder value through their abilities to sense and respond to changes in environmental conditions and threats in order to meet customers' value expectations. Arguably, transforming the pharmaceutical industry supply chain through S&R supply chain model will become a matter of adapt or perish. Adaptability invokes the ability of organizations to sense early (anticipate) and quickly respond to sudden changes in environmental conditions (Haeckel, 1999, Heinrich and Betts, 2004, Lee, 2004). For the pharmaceutical firms, it is the ability to S&R swiftly to changing business environment that will be required for firms to survive in the twenty-first century global economy and gain competitive advantage.

Just like other industries, the pharmaceutical firms can leverage S&R supply chain model to defend against counterfeiting and diversion of legitimate drugs. Every adaptive system survives by making sense out of its internal and external environments and responding with appropriate preemptive actions. The S&R supply chain Model with an Adaptive value chain Network depicted in Figure 4 (next page) presents how pharmaceutical firms can mitigate counterfeiting and diversion by sensing what is taking place in its environment.

Adaptive supply chain networks are communities of customer-centric organizations that must first sense what is going on in its environment, share knowledge, rapidly seize new business opportunities and responding to them while judiciously adjusting to changing business conditions (Haeckel, 1999). The ability to rapidly adapt to uncertain environmental changes is imperatively hinged upon S&R supply chain technologies such as RFID. Arguably, RFID-enabled S&R supply chain can provide near perfect real-world awareness of information regarding environmental changes. Real-world awareness is the firm's capability to sense information in real-time from its environment, including stakeholders and other relevant sources through RFID, sensor, agent-based distributed decision making, dashboards, event management, intelligent analytics and business processing integration and automation (IBM Business Consulting Services, 2005) to respond preemptively to unusual variations. Therefore, by means of RFID

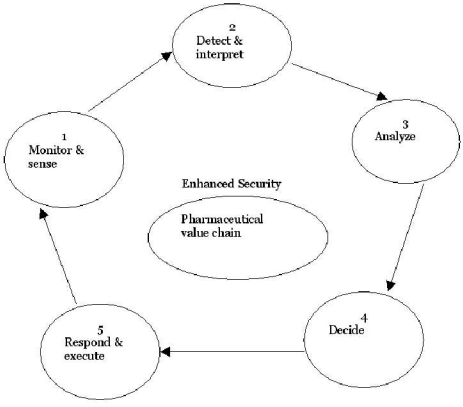


Figure 4: S&R Supply Chain with an Adaptive Value chain Network
Source: Adopted (& modified) from IBM (2005). "Transforming the Military through Sense and Respond." IBM Consulting Services.

technology, adaptive supply chain network can develop beneficial capabilities, including 1) monitor and sense, 2) detect and interpret, 3) analyze, 4) decide, and 5) respond and execute.

Because both the retail and pharmaceutical firms lacked the SR supply chain capabilities, they received more than $2 billion in product returns annually due to excess inventory or obsolete commodities (Philips Semiconductors et al., 2004). Saddled with about 1,300 recalls in 2001 due to one form of britches or another, the industry must look for better means of having visibility into its global PVC from manufacturing floor to medicine cabinet through RFID-enabled S&R supply chain model. Fisher (1997) asserted that "never has so much technology and brainpower been applied to improving supply chain performance" as is the case with RFID technology. Essentially, the ability to sense unexpected vulnerabilities and provide near real-time information to adapt supply chain processes to respond in the most efficient and/or timely fashion is imperative (Ferrari, 2006). Increasingly, because the pharmaceutical firms can no longer meet today's challenges with their current mitigating strategies, there is a serious need to look toward developing S&R supply chain capabilities. With RFID-based S&R supply chain, firms can achieve real time visibility on the status of products within and across enterprises. For example, according to FDA report, the pharmaceutical industry has been subjected to serious consequences because of the current level of counterfeiting that is estimated at 7-10 percent of the total market and growing annually. To reverse this trend, the pharmaceutical industry must evolve its supply chains into adaptive networks of supply chain partners that use technology to S&R in coordinated fashion to changes in their operational environment (Radjou, et al., 2002). Not only are firms' transition to S&R supply

chain evolutionary, but also it is more than ever urgent if firms want to be less vulnerable, less massive, more robust, and more effective. Thus, this means that firms must evolve along two premier trajectories; becoming more collaborative and adaptive (Castano-Pardo, et al., 2006).

Implications and Conclusions

As U.S. pharmaceutical manufacturing firms for better or worse shift their emphasis from sourcing and producing their products internally to outsourcing to low-cost destinations risks and uncertainty will continue to be prevalent. For example, increasingly, China and India have become the choice destinations for drug manufacturing because of 1) cost reduction strategy, 2) more flexibility with manufacturing and capacity, 3) lower labor costs, 4) capital does not need to be invested in machinery or plant capacity, and 5) not a core competency (Sun, 2006). There are many implications arising from this paper that can help to improve the minimization of PSC vulnerabilities and the risks of drug counterfeit and diversion. The types of risks considered in this paper, while imperative, are not the only risks facing global PSC. Among these other risks are parallel trade, gray market, changing government regulations, Sarbanes-Oxley Act and e-pedigree compliance, product, information, and financial risks. Although there exist in the literature strategies for addressing numerous supply chain vulnerabilities and risks, nowadays environment demands S&R supply chain model that can offer a better preemptive strike against PSC disruption risks. The pharmaceutical industry executives are facing the hard reality that risk of disruptions in the form of counterfeit to its legitimate drug supply chain can devastate public health, patient safety, and the bottom line. Indeed, supply chain managers must understand that inability to plan, measure, mitigate and manage risk elements in their supply chains can adversely impact drug quality, customer retention/confidence, brand strength, and financial performance. Regrettably, many pharmaceutical firms fail to recognize risk throughout all tiers of their supply chain.

To survive and thrive in the twenty-first century global economy means that pharmaceutical firms must learn how to adapt to today's turbulent. Therefore, to succeed, pharmaceutical firms must look towards the adoption of S&R supply chain that can help them to adapt and become resilient to sudden disruptions in their supply chains. Indeed, by becoming an adaptive enterprise, pharmaceutical stakeholders can afford to leverage the network's cumulative capabilities to sense events that can hamper plans as those events occur, and analyze them for impact; and respond to and learn from ever-changing business landscape (Heinrich and Betts, 2003). For example, the ever changing regulatory requirements, Sarbanes-Oxley Act, drug pedigree laws (track and tracing) and their compliance means firms have no choice but to adopt RFID-base S&R supply chain.

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