ABSTRACT

Many benefits of implementation of GDSN have been identified, including reduced counterfeiting, reduced medication errors, increased supply chain efficiency and standardized regulatory evolution. Several steps are involved in developing a GDSN and EPCglobal network. Each manufacturer, distributor, and retailer must have a strong ERP information system for the initial EPCIS set up. Next, a 2D barcode generator system should be obtained. Additionally, a web-based Datapool to connect the manufacturer, distributor, and retailer can help to reach the data synchronization stage. However, the most important step requires an open standard of GS1 global registry to enable the Epedigree through the supply chain system. When combined with EPCIS, EPCglobal standardization, and GS1 Global Registry, the supply chain can achieve global data synchronization and traceability.

INTRODUCTION

Healthcare is one of the world’s largest industries and the market size continues to grow each year. Specifically, the US pharmaceuticals market has increased rapidly over the past decade. Retail sales amounted to an estimated $409bn in 2010 (USA: Healthcare, 2009). However, the pharmaceuticals industry has encountered some major issues recently. For example, counterfeit drug sales are estimated to approach $75 billion globally in 2010. Some data show that as many as 98,000 patients die each year because of medical errors in the United States, which cost the healthcare sector from $138 billion to $192 billion. As for supply chain efficiency, administrative costs along supply chains in the healthcare industry makes up roughly 30 to 40 percent of healthcare costs, compared with 3 to 6 percent in grocery industry (DeJohn, 2008).

BENEFITS FOR GDSN IMPLEMENTATION

GS1 is a global organization which designs and implements global standards for efficiency and visibility of synchronization in the supply chain. GS1 Healthcare US systems of “3Gs”- Global Location Numbers (GLNs), Global Trade Identification Numbers (GTINs), and Global Data Synchronization Network (GDSN) – represent the standards adoption process for meeting e-commerce requirement in the global environment (Perrin, 2009). In November 2008, researchers at the University of Arkansas surveyed 1,381 healthcare providers and asked about the timeline for adopting data standardization. Out of 1,381 respondents, only 7 percent had already adopted GLN and 4 percent had already adopted GTIN system. The respondents said that the adoption of
GS1 Healthcare US system would definitely improve product tracking and decrease costs (Nachtmann & Pahl, 2009).

**OBSTACLES FOR GDSN IMPLEMENTATION**

However, there are some obstacles for members of the Healthcare industry seeking to enter the Global Data Synchronization Network (GDSN). Many companies admit trouble in calculating the cost of GDSN, given the major setup costs for electronic integration. Furthermore, many industry observers point out that given the current state of the internal product information supply chain, implementation of GDS demands large investments in process redesign and technical infrastructure. This is very different from the significant subscription fees to the home data pool and to GDSN (Legner & Schemm, 2008). Moreover, setting up the product master data items is the primary challenge and responsibility for the local manufacturers and sales units. Hence, corporate managers are not ready to invest in GSDN with so much uncertainty regarding the industrial standards. There are also security issues in applying EPCIS. The implementation of a GS1 standard involves managing information from the manufacturers through the retailer’s supply chain. Maintaining this information, which stores the EPC data to be secured, is a major concern. Fabian and Guther (2009) indicate that the most difficult part is that “all organizations in the supply chain will need to install new systems, software applications, and hardware components to capture, expose, and exchange requisite data.” Moreover, “since every change of ownership will require the exchange of item-level product, shipment, financial, and other data in an ePedigree file, all parties must be able to extract such data from multiple legacy and Enterprise Resource Planning (ERP) systems” (Slota & Humphreys, 2008).

Figure 1: Global Exchange of Product Master Data using the GDSN

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**EFFICIENT CONSUMER RESPONSE (ECR) MODEL**

Efficient Consumer Response (ECR) was introduced by Kurt Salmon Associated in 1993. Retailers, wholesalers, and suppliers are operated as one virtual unit under ECR strategy. Legner and Schemm (2008) stated that manufacturer, warehouse (manufacturer), warehouse (retailer),
store (retailer), and customer will interact as a whole under GDSN to identify the item-level process. Furthermore, they state that “supply management is on streamlining the supply chain by improving product replenishment, [whereas] demand management is aimed at creating and satisfying customer demand by optimizing product assortment strategies, promotions, and new product introductions.” Thus, information technology and process improvement tools can support the demand-side and supply-side connection.

**STEPS TOWARD GDSN AND EPCGLOBAL**

Legner & Schemn (2008) have defined seven steps (“Preparation”, “Publication”, “Registration”, “Search and Subscription”, “Identification of home data pool”, “Data Synchronization”, and “Receipt”) to implement the GDSN and EPCglobal. The different steps toward GS1 Global standard as indicated above (Figure 1). The timeline for this process would depend on each company’s capacity and its Enterprise Resource Planning (ERP) systems. The timelines obtained in similar studies have ranged from 6 months to 18 months. Additionally, Legner & Schemn’s model did not include some attributes such as distributor and the end user into the GDSN. We added the distributor (warehouse) and the end user into the model and modified the steps of Figure 1 which is shown in Figure 2: Supply Chain GDSN & EPCIS Model. However, we show only one warehouse as distributor, and this assumption is made for both manufacturer and retailer. The total steps toward global data synchronization increases from seven steps to total of twelve steps in Figure 2. Next, we will go through each step and estimate its costs.

**Figure 2: Supply Chain GDSN & EPCIS Model**

**Step 1A: Preparation – Information System (Manufacturer)**

The first step to implement the GDSN is to clean the entity’s data information system for a unique GLN (manufacturer, retailer) and GTIN (item-level). Nakatani, Chuang, and Zhou (2006)
suggested certain steps for internal data synchronization, such as standardization of data attributes to assessing the level of GTIN and GLN through integrating the databases and finally upgrading the IT systems. Therefore, the ERP is the initial step for setting up the IT system for adopting GS1 standards. Referring back to Figure 2: Supply Chain GDSN & EPCIS Model under the manufacturer step one “preparation” of information system, we use the most popular ERP system - SAP to estimate the cost. The reasons for choosing SAP is that it includes all the IT software systems from manufacturing resource planning to warehouse management for the supply chain planning.

Step 1A1: Preparation - SAP Estimated Costs (Manufacturer)

SAP is a well-known and commonly-used enterprise software application. SAP initial costs include the software license fee, consulting, hardware, personal, and training. The average initial cost for a big company which includes more than 1000 users is $1,853,333. As for a median company which includes around 550 users, the cost is $1,000,000. Regarding the ongoing costs, such as maintenance fees, SAP charges from 15% to 20%. The average annual cost of maintenance for big companies studied was $1,016,616, and the median maintenance cost amounted to $637,500 (Nucleus Research, 2003). Some companies find how to reduce costs from SAP by building major trading partners (Smith, 2008). This step can link the partners electronically and receive a better ROI from ERP usage. Some of the companies have built “communities of 4,000 to 5,000 trading partners” (Smith, 2008). Therefore, we estimate for implementing SAP as median users’ company to be $5,216,663.

Step 1A2: Preparation - 2D Bar Code (Manufacturer)

According to Lenger and Schemm (2008), “GLN is a 13-digit unique location number which identifies physical, functional, logical or legal entities in a supply chain.” Similarly, “GTIN is a 14-digit number used to uniquely identify a trade item so that it can be priced, ordered or invoiced at any point within the supply chain” (Legner & Schemm, 2008). GTIN is dynamic data which connects with manufactures’ databases. The Global Data Synchronization Network (GDSN) is also synchronization static data; moreover, “when product data is published at a GDSN-compliant data pool, it can be accessed from all other certified data pools based on the GS1 Global Registry, which acts as a global directory for the registration of items and parties” (Legner & Schemm, 2008). Please refer back to Figure 2: Supply Chain GDSN & EPCIS Model. Before we continue to Step 2 “Publishing”, each product should have a unique GTIN code. According to the Videojet website, “the backbone of a Track & Trace system is the ability to create and administer unrepeatable codes that cannot be emulated by unintended third parties.” Moreover, the product CodeMaster is one of the software products that “can generate fully random codes, create derived codes and incorporate Electronic Product Code (EPC) structures, or administer codes pre-generated from outside sources.” It is also pointed out that “the system is easily fed into other business applications, such as ERP, WMS and more.” The 2D barcode system includes cameras to verify the coding in every process from printing to packaging. It prints an individual GTIN code and also prints a label for the box for tracking purposes. Therefore, to generate unrepeatable codes, the manufacturers will need to purchase the hardware, software, cameras, and imager-based bar code readers. “Most imagers had been too large and expensive. The average list price of an array imager currently is around $3,000, compared with $1,000 for a high-performance laser scanner” (Wyatt & Reed, 2009). Videojet Technologies Inc.
provided us some relevant data regarding the system costs. If the pharmaceutical industry has an SAP system, it can handle the code generation. Therefore, the cost of Codemaster is not required. However, from Step 1A1, we recommend SAP system to be applied for preparation of the manufacturer information system. The total estimated costs for “Step 1A2: Preparation - 2D Bar Code (Manufacturer)” for one production line would be $100,000.

**Step 2: Publication – Home Data Pool (Manufacturer)**

Figure 2: Supply Chain GDSN & EPCIS Model shows that Step 2 is the “Publication” of Manufacturer Home data pool. To be able to estimate the cost of this publication data pool, we found GS1 Germany GmbH which recently conducted a pilot study called “The PROZEUS Project.” The project used “SA2 Worldsync” as its publication data system. According to SA2’s website, “the SA2 Worldsync Datapool allows retailers and suppliers to exchange master data on a global scale. This ensures an effective exchange of data for companies of all sizes and facilitates central business processes. The costs for SA2 Worldsync Item Master Data include one-time setup fee, hardware, and software, in addition to running costs. Investment for the one time setup fee is about €44,140 which is equivalent to approximately US$65,640. The average annual running costs are €5,440 which converts to about US$8,090. However, this pilot study is focused on small and medium size companies. We estimate that the publication costs could be approximately $147,500 for a large pharmaceutical company.

**Step 3: Registration – GS1 Global Registry (Manufacturer)**

After the company has set up the information system for Step 1: preparation and Step 2: publication with home data pool of manufacturer, the next step is the “Registration” to GS1 Global Registry Database. GS1 is looking at two key criteria for its fees by using GDSN: (1) company size (annual turnover, global) and (2) GTIN volume (low-medium-high). If a US pharmaceutical company has the global sales totaled $6294 million, the annual GS1 Healthcare US™ Membership fee is $10,000. However, there are additional fees when the company has GLN and GTIN involved. The exact costs of GLN and GTIN in the US could not be obtained; however, we found that European GS1 members needed to pay the following amounts in 2007: GS1 registration fee is approximately €400 and US$595. One GLN number is €284 and US$420. Initial costs for 100,000 GTIN licenses are €1,310 and US$1,950. Finally, the EPCglobal membership annual fee is €280 per year and US$416. Therefore, the total costs for GS1 global registry is approximately $13,000.

**Step 4A1: Search and subscription (Distributor) – Information System (SAP)**

SAP is a well-known software program for warehouse/logistics management system. Therefore, we will still use SAP-ERP information system to estimate the costs for this step. The distributor needs to have a complete ERP system to enhance communication among all the products they have to store and distribute. According to Quinn (2007), Expeditors Int’l of Washington is one of the top 10 global logistics providers. Expeditors is a US company which emphasizes healthcare area and manufacturers. We will refer back to Step 1A1 to list some of the SAP’s costs. Since Expeditors is a logistic company which focuses on warehouse function, according to Nucleus Research (2003) mySAP CRM system is to manage the customer relationship which is in the
$100,000 to $500,000 range. mySAP BW forms the core of the mySAP for business information warehouse system and the licenses fee ranges from $100,000 to $500,000. SAP R/2 or R/3 is focused on financials and operations management and ranged from $1,000,000 to $5,000,000.

The initial licenses fees for the above mySAP CRM, mySAP BW, and R/3 are estimated to be $1,200,000. The ongoing cost will use Step 1A1’s median company of a SAP deployment of approximately $2 million. Therefore, the total ERP system for distributor is $3.2 million.

**Step 4A2: Search and subscription (Distributor) - 2D Bar Code readers**

Since this is a warehouse or distribution center, the facility will need to use cameras to efficiently read the 2D bar codes from the pallets of merchandise. The manufacturer will attach 2D bar code labels onto pallets or boxes before sending products to distribution centers. Laser 2D bar code readers (scanners) or cameras can be used for checking the products in and out. One kind of reader is the camera system which can read a large area of the pallets. The estimated cost for the camera is $5,000. 2D barcode product provides wireless handheld reader can read the 2D barcode from a pallet. The wireless scanner is $2,000. We assume each facility will use around 10 readers. Therefore, the estimated cost for 10 readers is $20,000. Furthermore, the distribution center will need to have the software for the information system. The estimated cost for using the software (warehouse software module), hardware, and service is $26,000. Therefore, it will cost approximately $51,000 for one distribution center at this step.

**Step 4A3: Search and subscription (Distributor) - Home Data Pool**

As mention earlier from Legner & Schenn for search and subscription, the distributor searches for product information and subscribes to a manufacturer’s GLN and GTIN to get the related product and company information. Refer back to “Step 2: Publication – Home Data Pool (Manufacturer)” for searching the unique GLN and GTIN in the product; for consistency, we use the same SA2 Worldsync to estimate the Master Data system cost. Therefore, we will use the same amount that we estimated for Step 2 as $147,500.

**Step 5: Identification of source data pool (Distributor) – GS1 Global Registry**

The distributor uses the GS1 global registry data pool to identify the unique GLN and GTIN numbers. Regarding Step 3, the criteria for annual fees of GS1 is based on company size and GTIN volume. The distributor is not required to create a new GTIN number; therefore, the distributor only needs to pay the annual fee for using the GS1 database. According to Expeditors’ 2008 annual report, the company revenue for 2008 was $5,633 million. Therefore, the annual GS1 global registry Membership fee is approximately $10,000.

**Step 6: Data synchronization – Distributor & Manufacturer**

This step is for a distributor to receive and verify the related GLN and GTIN numbers from the manufacturer. Therefore, both data pools can be connected to achieve data synchronization. SA2 Worldsync Datapool are used for both manufacturer and distributor systems described earlier. Since the costs are already covered, there are no other extra costs to be paid.
Step 7: Receipt – Distributor

After the distributor verifies and receives the GLN and GTIN numbers from SA2 Worldsync Datapool and GS1 database, the information can be stored into the distributor’s own ERP system. Nakatani, Chuang, and Zhou (2006) state that “this is an extremely important point in the context of GDSN, because GDSN and EPCglobal Network share the core product information identification standards and can be complementary to each other.” One of the differences between GDSN and EPCglobal is that EPCglobal is a dynamic data which requires up-to-date information. Therefore, there are no extra charges for this step. By this step, the manufacturer and distributor have reached a partial EPCglobal network with a global traceability.

Step 8A1: Search and subscription (Retailer) – Information System (SAP)

Before retailers can accomplish search for manufacturers’ GLN and GTIN numbers, the retailers must have a well-established information system of their own. Some retailers might require connection to their ERP systems with their distributors or manufacturers. This step can help the integration of the product item numbers. As mentioned earlier, if the manufacturers and the entire supply chain can build a huge community sharing ERP systems, the expense for using ERP can be justified. We use CVS as our example retailer in this part. According to CVS’ 2008 annual report, the CVS Caremark operates around 6,900 drugstores with 8.75 billion in sales revenue. We will treat CVS as median users’ company with estimated SAP cost of $5,216,663. This includes set up and ongoing operation costs for a 3-year estimate.

Step 8A2: Search and subscription (Retailer) - 2D Bar Code readers

In order to read the 2D bar codes of the manufacturers’ products, every drug store of CVS needs to have 2D bar code readers (image array). Based on Imprint’s quotes, each reader costs $2,000. We assume each store needs two readers. With total of 6,900 CVS stores in US, the estimated costs would be around $13.8 million. However, the estimated costs for this part consider one store having two readers for a cost of $6,000.

Step 8A3: Search and subscription (Retailer) – Home Data Pool

In this step, the retailer obtains the product information from a common data pool. Here we will use the same system - SA2 Worldsync. SA2 Worldsync is a web-based database system which helps to connect the whole supply chain from manufacturer, distributor to retailer. The estimated costs for Step 8A3 is about $147,500. Please refer to Step 2 for detailed cost descriptions.

Step 9: Identification of source data pool (Retailer) – GS1 Global Registry

The retailer uses the GS1 global registry data pool to request the GLN and GTIN numbers. This step verifies the GLN and GTIN. The information is sent back to the data pool. Refer to Step 3 the criteria for annual fees of GS1 are company size and GTIN volume. The retailer does not create a new GTIN number; therefore, the retailer only needs to pay the annual fee for using the GS1 database. As stated above, CVS Caremark’s 2008 annual report stated that the company’s
revenue for 2008 was $8.75 billion. Therefore, the annual GS1 global registry Membership fee is approximately $10,000.

**Step 10: Data synchronization – Retailer, Distributor & Manufacturer**

SA2 Worldsync Datapool can help to synchronize the product information from the retailer, distributor, and manufacturer. We selected and charged SA2 Worldsync Datapool for the expense of data synchronization in Step 8A3. Therefore, no extra costs are involved for this step.

**Step 11: Receipt – Retailer**

After the retailer verifies and receives the GLN and GTIN numbers from SA2 Worldsync Datapool and GS1 database, the information can be stored in the retailer’s own ERP system. The sharing of the product information through GDSN and EPCglobal Network can reach a higher level of the global traceability standard for supply chain management in healthcare (GTSH). There will not be any extra charges for this step. By this point, the manufacturer, distributor, and retailer have almost reached a complete EPCglobal network with global traceability.

**Step 12: Record - Customer**

When retailers sell the products with EPCs to their customers, the retailers will have the records for each transition stored in the EPCIS. The combination of “detailed drug information with trade information, identifying buyers, sellers, product quantities, and shipping data” can create “an auditable record of change of ownership” (Slota & Humphreys, 2008). The costs are included in the internal information system that each retailer has already implemented in Step 8A1; therefore, no extra charges will be incurred in this step.

**SUMMARY FOR STEPS AND COSTS TOWARD GDSN AND EPCGLOBAL**

As noted above, several steps are involved in developing a GDSN and EPC global network. Each manufacturer, distributor, and retailer must have a strong ERP information system for the initial EPCIS set up. Next, a 2D barcode generator system should be obtained. Additionally, a web-based Datapool to connect the manufacturer, distributor, and retailer can help to reach the data synchronization stage. However, the most important step is to have an open standard of GS1 global registry to enable the Epidgree through the supply chain system. The costs of the complete supply chain GDSN model, which are estimated at $14,265,826. This figure represents the costs of one large-sized manufacturer with one production line, one large-sized distributor with one warehouse, and one large retailer with one store. If the manufacturer has five production lines, the extra costs only need to add the 2D bar code system and GTIN costs. As for distributor with more warehouses, the company would only need to purchase more 2D bar code readers or cameras. Finally, a retailer such as CVS with 6,900 stores in US would need to purchase thousands of 2D bar code readers. Many benefits of implementation of GDSN have been identified, including reduced counterfeiting, reduced medication errors, increased supply chain efficiency and standardized regulatory evolution (DeJohn, 2008). When combined with EPCIS, EPCglobal standardization, and GS1 Global Registry, the supply chain can achieve global data synchronization and traceability.
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