Serialization and the Future of Product Traceability

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Abstract *— Since the beginning of pharmaceutical products and drugs, counterfeiting has been a worldwide issue. Packed with minimal punishment, illegal internet sales and unsecured physical packaging, it has grown into an estimate market worth of over 75 billion dollars annually which represents a total of 5.8 percent loss to pharmaceutical companies. Even though 80 percent of the counterfeiting comes from overseas, Pharmaceutical Companies and worldwide Governments believe that counterfeiting can be reduced by implementing product serialization. This method has the potential to track and traced the product through the entire supply chain by uniquely identifying serial numbers, batch records, manufacturing and expiration dates. The ultimate goal for Pharmaceutical companies will be to trace the product lifecycle from production, distribution, and finally to the patient.*

Key words *— Counterfeiting, Pharmaceutical, Serialization, Traceability.*

INTRODUCTION

Ever since Pharmaceutical products have existed they have been susceptible to counterfeiting. This issue has cost the pharma companies trillions of dollars over the years and it continues to represent one of the biggest problems in the medicine industry today. The FDA defines a counterfeit medicine as a fake medicine, one that may be contaminated or contain the wrong or no active ingredients, and even though it could have the right active ingredient it will have the wrong dose.

Over the last decade, new technologies have been developing ways of fighting counterfeiting, however is this developing technology that represents the biggest problem for the drug companies. This give way to the concept of serialization, which applies an individual unique identifier to an individual pack of drug products [1]. In its simplest way, is the application of a serial number to any item or package.

Serialization also give way to product traceability, which makes it easier for manufacturers to track product through the entire supply chain, also it provides perhaps the most effective weapon he pharmaceutical industry has yet adopted to fight counterfeiting and ultimately protect its most valuable asset, the patients.

RESEARCH OBJECTIVE

The main objective of this project is to reduce counterfeiting, FDA penalties, pharmaceutical recalls and 100% traceability for all pharmaceutical drugs manufactured by implementing serialization to the drug industry.

RESEARCH BACKGROUND

The design project was conducted in a Pharmaceutical Manufacturing Company, code name Pharma 1 in Jayuya, P.R. This project is a part of a joint effort from the FDA and all pharmaceutical companies to include 100% traceability to their products, all the way form lot number to the costumer. The FDA's deadline for all pharmaceutical products to be serialized comes on 11/2017 which puts the company on a time sensitive position, giving the high product demand and facilities upgrade.

The company has been dealing with labeling issues on its currents presentations which include two bottle and one blister presentation. Before the implementation of serialization, generally the pharmaceutical companies used the lot number tracking system, however it only lasted three months since the FDA announced the introduction

of two new laws that will secure drugs in the supply chain.

In the war against counterfeiting the United States have led the charge by implementing the two new laws, first is the FDA Safety and Innovation Act (FDASIA) which came into law on 2012 will enhance the safety of the supply chain by giving each pharmaceutical manufacturing company a unique identifier. The second law is the Drug Supply Chain Security Act (DSCSA) enacted in November 2013, which mandates that by 2017 [2] [3] [4] products marketed in the United States must have serial numbers on the cases and packages of the pharmaceutical.

Since then globalization have hit the pharmaceutical industry with the necessity to look and challenge the global supply chain so they can minimize drug counterfeiting. A set of standards was created to minimize that headache and so the GS1 was developed. The GS1 is a non-profit organization that develops global standards for the identification of good and service. This organization works by implementing a serial of data formats in conjunction with applications identifiers to developed 2D barcode which will include a series of numbers which will be readable by code and those numbers will be traced back to the product and to the company whom manufactured it, on Figure 1 we can see an example of a 2D barcode with GS1 implementation traceability data. The GS1 2D Barcode is currently the most viable option for an international system because it allows manufacturers to standardize the process by which supply chain partners identify and serialize products.

Figure 1
2D Barcode with GS1 Applications

The DSCSA even though only applies to finished prescription drugs, the regulation outline critical steps to implement an electronic, interoperable system to identify and trace the drug as they are distributed through the United States. This will allow the client to access information on the drug through the entire supply chain. As we can see from figure 2 the finish good goes thru a series

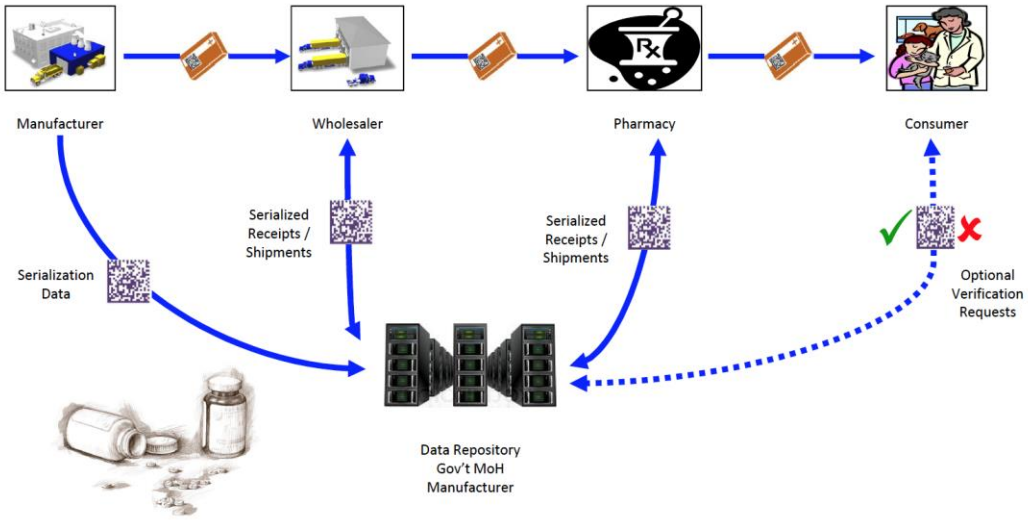

Figure 2
Serialization under DSCSA

of stops before getting into the hands of the consumer, however on every stop and even on the hands of the consumer there is a code checkup to double-check the serialize drug against the data stored on the data repository. Serialization also represents positive impacts on the industry for example:

- Product loss will be reduced due to much better product visibility as it moves through the supply chain
- Expiration date management will become more efficient
- Sales forecasting accuracy will increase as real time data flow into the chain
- Product diversion incidents will be reduced
- Inventory of finish goods and consumables will be enhanced

Multiple anti-counterfeiting technologies have been introduced over the last two decades as part of product serialization. With the increase in counterfeiting, Authentication Technologies play an important role in supporting product brand strategies, helping to reduce the risk of product fraud and enabling stakeholders to identify and track genuine products with the fake one [5]. Figure 3 shows how the Anti-Counterfeiting market will grow with the improvement of serialization.

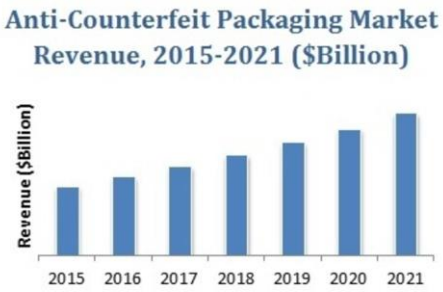

Figure 3
Analysis on trends for Anti-Counterfeiting Tech

Today, there are various technologies for product authentication in the market, although all are applied on these three main areas:

1. Anti-Counterfeiting
2. Anti-Tampering
3. Track and Trace

Anti-Counterfeiting: The common feature of anti-counterfeiting technologies is that they are extremely difficult to be counterfeited. Consequently, they help in identifying a genuine product.

Anti-Tampering: mostly seen on the food and pharmaceutical industry where there is a need to protect the product from adulteration or replacement. Also is an indicator or barrier to entry which, if breached or missing, should provide visible or audible evidence to consumers that tampering has occurred.

Track and Trace: This authentication technology uses mass serialization to assigned a unique identifier to each stock unit (SKU). Then IT Technologies allows the authorize user to keep track of this SKU across the entire supply chain. Depending on the user authorization level, they may also be able to access additional information of that product, such as manufacturing date, expiry date, lot number, etc.

All of these technologies discussed above can be categorized either Overt, Covert, Forensic or Digital.

- **Overt**: Overt technologies are authentication devices built into labels, documents and packaging which are visible to the user and show dynamic visual effects. Their main advantage is on the spot visual authentication where no additional devices are needed. This feature is expected to fulfill three main aspects:
  - ⇒ Communicated with the verifier
  - ⇒ Easy to identify
  - ⇒ Hard to copy or imitate

Some disadvantages from Overt features are that they require user education, some users are not familiar with the identification methods. Also, they can be re-used, refilled and can provide false assurance. Some examples of Overt features are Holograms and color-shift ink.

- **Covert**: Covert technologies are not instantly recognizable. They require a special reader or detector to be able to verify their presence and validity, and people using covert technologies

will normally require some kind of training. They are easily added or modified and low cost, however, they need strict measures of secrecy, which constitute in a high risk of compromise. Some examples are: embedded images, digital watermarks and invisible printing.

- **Forensic**: Forensic feature are considered Covert; they are not readily recognizable and require special tools for detection and validation. Whereas covert technologies can be detected and validated in the field, forensic technologies must often be taken to a laboratory with specialized equipment. Some advantages of Forensic features are high-tech and secure against copying and provide positive authentication, however, they can be difficult to implement and control across the supply chain, also is significantly expensive compare to the other features.
- **Digital**: Digital technologies may be either overt or covert, but all require an electronic means for detection and validation. Digital technologies are most associated with RFID (Radio Frequency Identification) tags or with serialized numbers that can be compared to a remote database.

RESEARCH METHODOLOGY

The Method that will be utilized on this research based on the problem solving nature is the six sigma DMAIC approach. DMAIC is the acronym with five phases: Define, Measure, Analyze, Improvement and Control.

- **Define Phase**: This phase consists on getting to know the customer and what are the projects expectations and overall goals, potential resources and project scope which typically will be documented in a project charter.
- **Measure Phase**: The Measure Phase consists of data analysis and numerical studies. Also, is where the measurement of system validation and gathering root causes take place.
- **Analyze Phase**: This phase is where the statistical analysis for the problem begins. Also, is where the Critical to Quality (CTQs) are identified, which are the parameters that relates to the needs of the customer.
- **Improve Phase**: The purpose of the Improve Phase is to identify a solution to the problem. This involves brainstorming potential problem solutions and put them into practice.
- **Control Phase**: The main focus of the Control Phase is to make sure that the solution proposed on the Improve Phase are well-implemented and maintained.

METHODOLOGY RESULTS

This section consists of the results obtained based on the analysis conducted by implementing the DMAIC Method.

Define

Pharmaceutical counterfeiting has been on the rise for the last 25 years. Pharma industries on this day need to introduced new ways to battle counterfeiting. As part of the government efforts to increase security for pharma industries and ultimately to the patients, the project consists of introducing a Serialization Project.

The project scopes include the implementation of a new Track and Trace system for the entire range of products manufacture on Pharma 1 located at Jayuya P.R. Also, introduce new technology to upgrade already installed equipment and validate this equipment so it complies with Government regulations.

Measure

For us to understand the customer needs we need to understand the different types of process, product, suppliers and customers, so we identify the possible solutions by studying the packaging process which is the one we are using for product serialization.

- The packaging process starts by receiving a single or multiple manufacturing lots to be

packed either for domestic or international presentations.

- After the lots are received, the product goes through a primary packaging process.
- The primary packaging goes through a labeling machine which puts a label identifying that lot number and serial number for that particular lot.
- Finally, the product goes through a secondary packaging which is labeled again and palletized as per batch records.

In the current packaging line there is no serialized product, nor there the required equipment for serialization. Figure 4 will illustrate the current equipment and their serialized status.

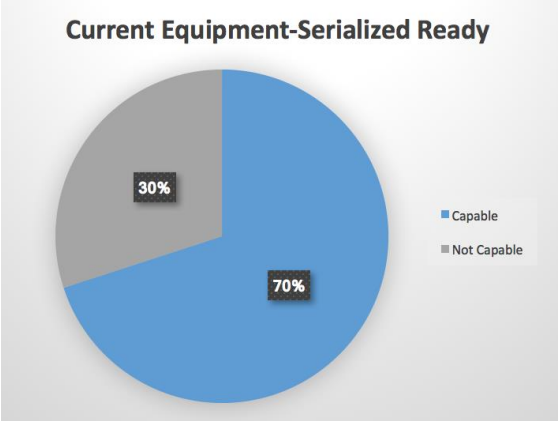

Figure 4
Current Equipment Status for Serialization

Based on this data compiled and by studying the current packaging system, we can start focusing on the possible solutions.

Analyze

On this phase of the project we will analyzed all the data compiled and identify the opportunities for improvements. Pharma1 actual packaging system is not capable of committing 100% product serialization as you can see on figure 4, however the good news is that 70% of the equipment is capable of going through the serialization process.

The opportunities we pay more attention on Pharma 1 giving their critical elements are gathered in a CTQ Tree (Figure 5). The three parameters we considered to be the more critical are: cGMP (current Good Manufacturing Practices), Cost and Infrastructure. The first one (cGMP) is probably the most critical, giving the fact that we need equipment and personnel but everything most comply with national and international laws. New equipment must be validated within a timeframe and personnel most be trained in their respective areas and new systems.

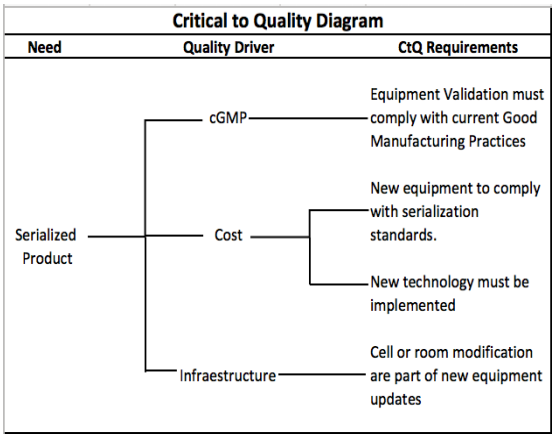

Figure 5
Critical to Quality (CTQ) Tree

The cost quality driver speaks for itself. Management sets a limited budgetary control to implement the serialization system and all that implies, which we classified as follows:

- Equipment
- Contractors (internal and external)
- Information Technology
- Suppliers

New equipment is the base of the project and the biggest percentage of the budget is dedicated to implement these new technologies. Personnel that directly or indirectly will be involved in the implementation and ultimately operating the system like operators, engineers, super-users, etc. IT is involved because almost the entire system is online, hands on scanning will be implemented for worst case scenarios (power failure, server down, etc.), moreover the fact that the majority if the computerized equipment must comply with data integrity specifications. And the suppliers, these are the people that will install and will finalized the

equipment settings so the serialization process runs smoothly.

Finally, infrastructure. The plant will go through a modification phase due to equipment measurements and relocations, which will have a major impact on facilities and maintenance.

Improve

The propose new serialization equipment will serialize product from the get go. First, the bottle unscrambler will have a printer integration, this printer will print a 2D barcode on the bottle which will identify it with the lot data. After the bottle is fill and caped it will pass through a brand new labeler machine with serialized master tracking system. On this section of the serialization process the labeler will attach a human readable label with a second 2D barcode which the master tracking system and sophisticated high speed cameras will then match it with the one printed on the bottle on the first step of the process. The Outsert (product instructions) will be attached to the label after this one is stick to the bottle.

The master tracking system will call upon a corporate tracking system. This corporate tracking system will enter a database and extract a set of serial numbers which will then pass to the master tracking system so each bottle will have their own unique serial number.

The last step of the process is the Case Packer/Palletizer. This is the most critical step, first the product will be extract and before boxing them, a high speed camera will photograph for the second time the bottom of each bottle and match it with the 2D on the first step and the label 2D and label data. This information passes through a packaging tracking system which will communicate directly with the master tracking system to match each bottle to their barcode and label data. Then the bottles go through a boxing stage, however if there is a bottle or set of bottles which their label or 2D won't match, that particular box will be rejected and put on for rework.

Finally, once bottles are boxed a print and apply printer attached a label with information regarding expiry date, manufacturing date, dose, lot #, etc. For the palletizing stage, once the box is picked up for pelletizing, another camera takes one last photograph and match the box label with the bottles and labels inside that particular box. Once the product is palletized, the pallet and the case will go through a father child relation and this is the aggregation step which will finalize the serialization process.

By implementing this process (Figure 6), the product will be followed all through the supply chain making it more difficult to be tampered, also providing patients and suppliers with a safe and reliable product.

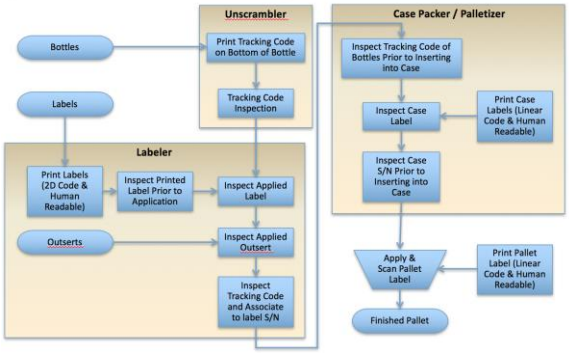

Figure 6
Serialization Process Flow

Control

With a 100% equipment capable of going through the serialization phase, we must maintain and make a profitable future for Pharma 1. To do this we must make sure every aspect of the process is covered. However, the critical part of the serialization process is whether the cooperate, master and packaging tracking systems are consistently running and without unexpected failures during regular production. To do this we are implementing a rigorous and business jointly Preventive Maintenance System, what this will do is that the entire system will go through a PM schedule from monthly, quarterly, semi-annual and annual checkups to prevent system failures.

Moreover, a training program that will ensure employee knowledge and understanding. Implementing visual aids for equipment

understanding and On the Job Training (OJT) for supervisors and floor mechanics.

Equipment support is crucial, just like the Tracking System, serialization equipment must have a Bill of Material (BOM) on site which will give the engineering department the tools to maintain the packaging line on constant production. Together with schedule validations and PM system controls all new and existing equipment will provide the results Pharma 1 is expecting to achieve before National serialization standardization takes off.

CONCLUSION

Patient safety and an untampered product is the main focus for Pharma 1 and all Regulatory agencies around the world. Implementing serialization will build trust between patient and manufacturer, because you are giving access to the product's entire supply chain which will increase product sales and will minimize counterfeiting complaints which can result in product recall or worst.

Serialization, even though is an expensive implementation, it does come with some guarantees. First, it will reduce product adulteration, giving Pharmaceutical industries larger profits. Second, it creates a crystalized relationship between manufacturer and consumer. And third, it allows the industry to operate outside the shadows of the stakeholders and regulatory agencies.

Finally, as the serialization dateline comes to a close pharmaceutical companies' goals are to create a stronger a safer path for their product to the consumer and by serializing their products this can potentially change the industry for years to come.

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