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1.1 OPENING VIGNETTE: Magpie Sensing Employs Analytics to Manage a Vaccine Supply Chain Effectively and Safely

Cold chain in healthcare is defined as the temperature-controlled supply chain involving a system of transporting and storing vaccines and pharmaceutical drugs. It consists of three major components—transport and storage equipment, trained personnel, and efficient management procedures. The majority of the vaccines in the cold chain are typically maintained at a temperature of 35–46 degrees Fahrenheit [2–8 degrees Centigrade]. Maintaining cold chain integrity is extremely important for healthcare product manufacturers.

Especially for the vaccines, improper storage and handling practices that compromise vaccine viability prove a costly, time-consuming affair. Vaccines must be stored properly from manufacture until they are available for use. Any extreme temperatures of heat or cold will reduce vaccine potency; such vaccines, if administered, might not yield effective results or could cause adverse effects.

Effectively maintaining the temperatures of storage units throughout the healthcare supply chain in real time—i.e., beginning from the gathering of the resources, manufacturing, distribution, and dispensing of the products—is the most effective solution desired in the cold chain. Also, the location-tagged real-time environmental data about the storage units helps in monitoring the cold chain for spoiled products. The chain of custody can be easily identified to assign product liability.

A study conducted by the Centers for Disease Control and Prevention (CDC) looked at the handling of cold chain vaccines by 45 healthcare providers around United States and reported that three-quarters of the providers experienced serious cold chain violations.

A WAY TOWARD A POSSIBLE SOLUTION

Magpie Sensing, a start-up project under Ebers Smith and Douglas Associated LLC, provides a suite of cold chain monitoring and analysis technologies for the healthcare industry. It is a shippable, wireless temperature and humidity monitor that provides real-time, location-aware tracking of cold chain products during shipment. Magpie Sensing's solutions rely on rich analytics algorithms that leverage the data gathered from the monitoring devices to improve the efficiency of cold chain processes and predict cold storage problems before they occur.

Magpie sensing applies all three types of analytical techniques—descriptive, predictive, and prescriptive analytics—to turn the raw data returned from the monitoring devices into actionable recommendations and warnings.

The properties of the cold storage system, which include the set point of the storage system's thermostat, the typical range of temperature values in the storage system, and

the duty cycle of the system's compressor, are monitored and reported in real time. This information helps trained personnel to ensure that the storage unit is properly configured to store a particular product. All the temperature information is displayed on a Web dashboard that shows a graph of the temperature inside the specific storage unit.

Based on information derived from the monitoring devices, Magpie's predictive analytic algorithms can determine the set point of the storage unit's thermostat and alert the system's users if the system is incorrectly configured, depending upon the various types of products stored. This offers a solution to the users of consumer refrigerators where the thermostat is not temperature graded. Magpie's system also sends alerts about possible temperature violations based on the storage unit's average temperature and subsequent compressor cycle runs, which may drop the temperature below the freezing point. Magpie's predictive analytics further report possible human errors, such as failure to shut the storage unit doors or the presence of an incomplete seal, by analyzing the temperature trend and alerting users via Web interface, text message, or audible alert before the temperature bounds are actually violated. In a similar way, a compressor or a power failure can be detected; the estimated time before the storage unit reaches an unsafe temperature also is reported, which prepares the users to look for backup solutions such as using dry ice to restore power.

In addition to predictive analytics, Magpie Sensing's analytics systems can provide prescriptive recommendations for improving the cold storage processes and business decision making. Prescriptive analytics help users dial in the optimal temperature setting, which helps to achieve the right balance between freezing and spoilage risk; this, in turn, provides a cushion-time to react to the situation before the products spoil. Its prescriptive analytics also gather useful meta-information on cold storage units, including the times of day that are busiest and periods where the system's doors are opened, which can be used to provide additional design plans and institutional policies that ensure that the system is being properly maintained and not overused.

Furthermore, prescriptive analytics can be used to guide equipment purchase decisions by constantly analyzing the performance of current storage units. Based on the storage system's efficiency, decisions on distributing the products across available storage units can be made based on the product's sensitivity.

Using Magpie Sensing's cold chain analytics, additional manufacturing time and expenditure can be eliminated by ensuring that product safety can be secured throughout the supply chain and effective products can be administered to the patients. Compliance with state and federal safety regulations can be better achieved through automatic data gathering and reporting about the products involved in the cold chain.

QUESTIONS FOR THE OPENING VIGNETTE

1. What information is provided by the descriptive analytics employed at Magpie Sensing?
2. What type of support is provided by the predictive analytics employed at Magpie Sensing?
3. How does prescriptive analytics help in business decision making?
4. In what ways can actionable information be reported in real time to concerned users of the system?
5. In what other situations might real-time monitoring applications be needed?

WHAT WE CAN LEARN FROM THIS VIGNETTE

This vignette illustrates how data from a business process can be used to generate insights at various levels. First, the graphical analysis of the data (termed *reporting analytics*) allows