Chapter 4
Improving Healthcare with Data-Driven Track-and-Trace Systems

Eldar Sultanow
XQS Service GmbH, Germany

Alina M. Chircu
Bentley University, USA

ABSTRACT

This chapter illustrates the potential of data-driven track-and-trace technology for improving healthcare through efficient management of internal operations and better delivery of services to patients. Track-and-trace can help healthcare organizations meet government regulations, reduce cost, provide value-added services, and monitor and protect patients, equipment, and materials. Two real-world examples of commercially available track-and-trace systems based on RFID and sensors are discussed: a system for counterfeiting prevention and quality assurance in pharmaceutical supply chains and a monitoring system. The system-generated data (such as location, temperature, movement, etc.) about tracked entities (such as medication, patients, or staff) is "big data" (i.e. data with high volume, variety, velocity, and veracity). The chapter discusses the challenges related to data capture, storage, retrieval, and ultimately analysis in support of organizational objectives (such as lowering costs, increasing security, improving patient outcomes, etc.).

INTRODUCTION

The healthcare sector is an important driver of economic growth in many countries around the world. In 2013, it is estimated that $6.15 trillion were spent on healthcare worldwide, with the majority of the expenditures and the largest percent of a country's wealth being observed in the US (18% of GDP) and other developed countries such as the Netherlands (11.9% of GDP), France (11.6% of GDP), Germany (11.3% of GDP), Canada (11.2% of GDP) and Switzerland (11.0% of GDP) (Hoovers.com, 2013; Plunkett Research, 2013). However, many healthcare organizations today are faced with increasing challenges, including government regulation, stringent safety

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requirements, aging population, increasing labor costs, and expensive medical equipment and pharmaceuticals. Manufacturers of medications, medical technology, and supplies, hospitals, nursing homes, doctor's offices, pharmacies, and other healthcare sector players all need to better control costs, safety, and quality in order to successfully meet patient needs, regulatory requirements and competitive pressures.

One information technology (IT) touted for its potential to improve processes and reduce costs is big data – a term coined to reflect very large and complex data sets, which can be analyzed using sophisticated tools to extract improvement insights. Annually, the healthcare sector in the US alone could generate $300 billion in value and a productivity increase of 0.7% from using big data. Big data can also create new markets, such as a market for medical clinical information providers, which his predicted to reach $10 billion by 2020 (Manyika et al., 2011).

Traditionally, big data was defined in terms of three dimensions - volume, variety, and velocity. Recently, a fourth dimension, veracity, was added (IBM, 2014). Volume refers to the size of the data sets, which is considered too large to be managed using traditional database tools. Volume is time and industry-dependent: today, big data range from hundreds of terabytes (10^{12} bytes) of data (the volume stored by most US companies today) to pentabytes (10^{15} bytes) of data, but these volumes are expected to increase in the future as more detailed data is captured (Manyika et al., 2011; IBM, 2014). Variety refers to the different types of structured and unstructured data such as traditional transactional data as well as data from sensors, social media, mobile devices, and other real-time monitoring technologies. Velocity measures the speed of streaming the data –in near real-time or fully real-time. Finally, veracity refers to the degree of certainty in the data –in terms of sampling rates from a population or in terms of data quality, for example (IBM, 2014).

While the academic and practitioner communities have focused heavily on explaining the value of big data, they did so largely in generic terms, with little attention given to the technologies and information systems that make big data happen. This chapter presents two real-world case studies of data-driven track-and-trace technology. Tracking and tracing were terms originally defined in the context of supply chain management. Tracking implies collecting data about product location and movement from a supplier to a customer, throughout the supply chain. Tracing denotes the retrieval of the tracking information in order to identify a product's real-time location, past movements, or origin (Ha & Choi, 2002; Laurier & Poels, 2012). As sensor technologies evolved, track-and-trace technology today can capture and retrieve not just location, but other types of data, such as temperature and acceleration of objects and vital signs of people, and do so reliably and in real-time. Thus, track-and-trace technologies generate data in high volumes and with high variety, velocity and veracity. We believe that understanding their technical architecture and benefit affordances is essential for helping healthcare organizations analyze this data and generate value.

Track-and-trace technologies enable "real world awareness" (RWA) – a term originally coined by SAP and defined as "the ability to sense information in real-time from people, IT sources, and physical objects – by using technologies like RFID and sensors – and then to respond quickly and effectively" (Heinrich, 2005). RWA is intended to reduce or resolve breaks in information sensing and responding, and thus closes the gap between the natural and the virtual world. The natural world comprises physical and operational reality, e.g. people, products, inputs and resources, while the virtual world consists of the depiction of reality in IT, i.e. in IT systems and local, regional and global information networks. The RWA concept is based on the growing trend towards automatic data entry and retrieval processes and an ever-increasing wealth of available information.

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