# Enhancing Healthcare Supply Chain Performance Through Barcoding and Business Intelligence

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# Enhancing Healthcare Supply Chain Performance Through Barcoding and Business Intelligence

**Mr. Sudesh Zingde \*, Dr. Neha Shroff \*\***

**\* Doctoral Scholar, School of Doctoral Research and Innovation, GLS University, Ahmedabad, Gujarat.** *OrcID : https://orcid.org/0000-0002-8782-746X*

**\*\* Assistant Professor, Faculty of Business Administration, GLS University, Ahmedabad, Gujarat, India** *, OrcID : https://orcid.org/0000-0003-3386-8837*

**Abstract:** In recent years, the healthcare sector is under constant pressure to have efficient supply chains with high speed, high accuracy and a complete traceability of products throughout the supply chain. Such complex supply chain management can be simplified using barcode technology for automatic identification and data collection. The barcoding systems are becoming popular in many industries as they reduce human errors, save time and improve accuracy in entire supply chain when effectively implemented. The vast amount of data captured through the barcoding and warehouse management system can be transformed into useful business insights using business intelligence dashboards that help in decision-making and performance management. The study included in-depth interviews of 12 supply chain professionals in healthcare industry who have been using barcoding and business intelligence systems. The interviews were conducted with some senior managers from healthcare industry to understand the perspectives on how barcoding and business intelligence could help the organizations in better supply chain optimization, cost control and performance management to stay ahead in the fast changing world by building sustainable supply chains. This paper examines how barcoding and business intelligence can help in achieving these goals. The findings can serve as a guide for business managers in implementing effective barcoding systems and making best use of the data for business analytics in making effective decisions and enhance business performance.

**Keywords** — *Barcoding, Traceability, supply chain visibility, warehouse processes, Business Intelligence, Performance Management*

## I. INTRODUCTION

In today's era of global competition, organizations strive to improve their competitive advantage, supply chain visibility and timely information flow to remain agile and resilient. Automatic identification and data collection (AIDC) technology, such as barcoding, can greatly increase supply chain visibility [1]. In recent years, global healthcare is going through a significant transformation of its information systems and digital solutions play an important role to tackle this challenge [2]. Barcode is a form of technological development that is able to store data so that it can be well integrated in a system that enables tracking of incoming goods , quick and accurate counting and track them all the way through manufacturing , packing , storage and dispatch process simply by scanning the barcodes [3]. Barcoding can greatly simplify warehouse management system (WMS) and helps to minimize human error , improve speed and provide accurate data in a real-time by integrating various process and improves efficiency in the WMS [4]. With complex global supply chains and growing customer expectations and competition, business organizations constantly need all possible ways to optimize the resources, deliver products and services on with high speed and ON TIME. The business managers continuously need business insights , not just information [5] at right time and format to take timely and effective decisions to achieve organizational goals efficiently. Data analytics and Business Intelligence (BI) help in gathering , storage and analyzing data to present as actionable information to help business managers in making informed business decisions [6]. Global research organization - Kenneth Research has projected the global BI Market to reach USD 147 Billion by 2025. BI tools assist in transforming huge and complex data into reliable intelligence and facilitates sharing information to the right people at right time using visual dashboards, scorecards & reports. Data quality, user access , integration and other technological capabilities are necessary for BI success[7].

User quality and content quality were significant factors contributing to use of information from the BI Systems [8]. BI dashboards provide at-a-glance information to the

decision makers like the dashboards in aircrafts and cars. BI Dashboards and scorecards help in providing business insights, performance management, Key Performance Indicators (KPI) monitoring. Performance dashboards are a commonly used management tool for performance monitoring and assist the decision maker to make better decisions faster. BI transforms complex data into actionable information and business insights and with vast amounts of data, most companies are trying to exploit data for competitive advantage [9].

Despite substantial corporate investments in barcoding and BI systems, many organizations have not fully gained the best advantages of these technologies. Very few studies examine impact of barcode data and its usage through BI dashboards. This research fills this gap in knowledge by examining the practical implication of both barcoding system and the effective use of data using BI dashboards. This study is significant as it provides insights to supply chain professionals. Our study addresses these research questions by 12 in-depth interviews conducted with supply chain /industry professionals. The industry professionals were senior managers & decision makers from pharmaceutical industry. The research questions were aimed to investigate whether barcoding and BI enabled improvements in speed, efficiency and traceability.

## II. RESEARCH METHODOLOGY

A literature review around supply chain visibility, supply chain design, and standard adoption issues was carried out based on keywords in research databases for search using keywords: "Barcoding", "GS1", "traceability", "Warehouse management "," Business Intelligence "," Data Visualization "," Performance management". The articles were filtered according to their relevance and were reviewed to present a summary of the most important and relevant findings in complex global healthcare supply chain operations.

The next section briefly reviews important studies related to barcoding and use of related data for business analytics or BI dashboards. This is followed by a methodological approach for answering the research questions. We then present our findings, synthesize them & finally conclude the paper with a discussion of our contributions and limitations of our study.

**B**arcoding consists of data in a visual, machine-readable form and uses a sequence of vertical lines, dots, characters and spaces to represent a barcode that can be read by scanners to interpret the code as well as its associated attributes. The barcodes have become the backbone of streamlined supply chain management to improve speed, efficiency and traceability, which has encouraged many organizations to implement barcoding technology. [10]. Barcodes are of 2 types:

a) 1D or linear barcodes represent data by varying the width and spacing of parallel lines that can holds under 85 characters (symbology particular character limit) and these are most commonly used barcodes due to the width that enables printing of human readable barcode text for human interpretation.

b) 2D Barcode Visual two-dimensional way of representing information. It is similar to a linear /1D barcodes, but has more data representation capability and can hold up to about 2000 characters of *information*.   2D barcodes, such as data matrix, QR code have patterns of square, dots, hexagons and other geometric patterns and can pack more information into the same space.

Barcodes helps in automating the inventory management process by keeping record of all the goods in stock as well as various transactions throughout the supply chain and could be extended throughout the product life cycle. It also makes precise inventory data accessible in real time and practically at any location. Barcoding has emerged as revolutionary technology for Auto Identification and information exchange and is commonly used in global supply chains as economical and easy mechanism for auto identification of products and capturing the data into the systems by simply scanning barcodes. The use of barcoding offers better services at low cost and helps in management of inventory of products with accurate data on batch number, serial number or expiry dates based on the barcode configuration [11]. Barcodes are scanned using a barcode reader or scanner, which is an optical device that reads the barcode characters and send the data to a computer.  Hand held scanners with a touch screen and trigger button are commonly used in supply chain operations due to its flexibility. Barcodes make tracking processes faster when compared to manual mode. [12]. Barcoding system, if correctly implemented, can help the supply chain in various manners:

Managing product and its associated transactional information during entire supply chain is challenging [13]. A Global Trade Item Number (GTIN) is used to identify any item uniquely within a global, open environment at any point in any supply chain. GTIN is constructed from a company prefix , an item reference number designated by the company, and a check digit.

The unique GTIN numbers and attributes helps the organization to quickly respond to the customer queries to identify most appropriate product and also identify the exact attributes in terms of packing , dimensions , weight , volume , etc. The GTIN provides a Supply Chain solution for the identification of any item and overall Supply Chain costs are minimized by all partners in the Supply Chain adhering to identical allocation rules as laid down in this publication [14]. GTINs include codes that identify the manufacturer of

the products and can relate the product category, its manufacturing locations (GLN) when smartly coded.

Especially pharmaceutical supply chains are today facing an increasing problem with counterfeit medicines worldwide and supply chain traceability is becoming critical to enable verification of authenticity for pharmaceutical products and to prevent counterfeit products to reach end consumers [15]. Growth of international free trade and inadequate drug regulation have led to the expansion of trade in counterfeit drugs worldwide & barcode technology has been used as cost effective and ideal solution to resolve counterfeiting problem [16]. With GS1 barcoding, this problem can be resolved with serialization that includes unique identity of individual physical items. When combined with track and trace technology, serialization facilitates the tracking of a product throughout the supply chain and allows for targeted identification of products for recall.  Customers and regulators in healthcare expect a complete batch tracking system that helps to trace back in the supply chain and manage the quality control process. Traceability system helps to improve the efficiency of supply chain management process by reducing the costs, providing all the information from product conception to retail in the market.

As outlined in Figure 1, global supply chains have become very complex today with multiple stakeholders globally, who need to collaborate for efficient management. Traceability has become a critical component of the supply chain management that track and trace the information about the product throughout the supply chain [17]. Growing competitive markets demand the companies to have their supply chain management process agile, effective and efficient. Automated Identification using barcode scanning can provide quick information with the identity of each a physical item in the supply chain in an efficient and timely manner and gives major opportunity to overhaul and improve traceability, process control and inventory management [18].  The implementation of barcode in warehouse management system has many benefits including speed and efficiency improvement, simplify racking and picking, improve data accuracy, improves customer service, reduce the possibility of stock out, reduce handling costs in warehouses, and reduce human errors [19].

Supply chain visibility is among the top concerns expressed by many supply chain leaders. [20]. The extensive use of barcodes as identification standards in healthcare products can contribute to the reduction of errors and can increase the efficiency of healthcare supply chain related processes [21].
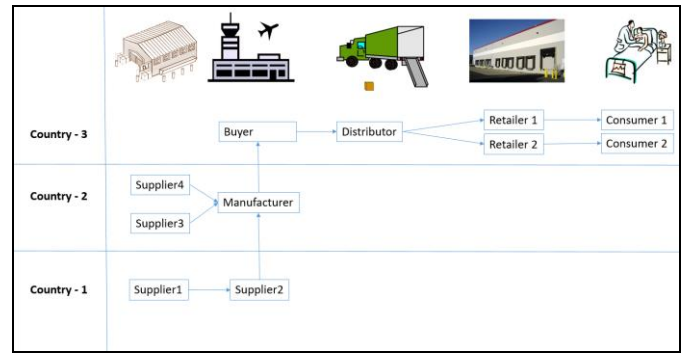


Figure 1: Complex global supply chain involving multiple stakeholders

The need for a reliable identification and tracking system is essential to ensure the safety and quality of products reaching the consumer and Vitality of traceability has increased substantially. Traceability has now become a new parameter of quality and basis for trade across the borders and facilitates effective recall of products [22]. As can be seen in Figure 1, the global standard for healthcare can serve as a foundational standard in supply chain covering multiple counties and ensure a common approach and understanding of key principles by users around the world [23]. Good traceability systems help to ensure safe and high quality product and distribution thereby minimizing the potential for liability, and costly product recalls. Drivers for traceability – adapted from [24].

To make supply chain effective, efficient and agile, the data and information of the product at every point of the supply chain must be traceable throughout the processing history in supply chain across locations  [17]. Traceability of data through transformation stages of each individual product, starting from raw products and to the final product, as well as printing the key data on the product package, adds to the consumers' trust in product quality [25]. Many supply chain Management system are adopting barcoding technology that is integrated with the ERP and WMS system [26] for tracing and tracking their products at various levels. Study by [27] investigated how barcode based tracking system helps the product manufacturers and supplier in recalling products distributed to the customers [28].

In supply chains, the challenge is to keep trace of objects manufactured, to track their locations in a production and distribution processes. Traceability is also increasingly seen as a mean to improve efficiency of the logistics of care and a way to better understand costs and usage of resources [29]. Product recalls in the healthcare industry contribute to significant supply chain disruptions and emphasis on supply chain and logistics. The product recalls in healthcare have been increasing for a variety of reasons causing significant supply chain disruptions in recent years and this critical process requires information accuracy and efficient notification system. Traceability mechanism makes it possible to locate and identify current product ownership,

facilitates product tracking communicating recall information and helps to recover or safe disposal of the product [30].

Global Standard (GS1) is a standard implemented by global organization that has set up standards for identification of the products and tracing the flow throughout the supply chain with batch numbers. GS1 code is a global commodity bar code widely used in commercial storage logistics, product tracing, and production automation. The GS1 organization was formed in early 2005 and the GS1 system of global data standards is emerging as the long needed approach to gaining the efficiencies using universally accepted identifiers for products and partners/locations [31]. The use of GS1 data standards is a globally accepted system to uniquely identify products and helps to improve efficiency and traceability across supply chain operations. GS1 provides the unique identification of all trade items, services, logistic units, consignments, assets, documents, relationships, parties and locations at any point in the supply chain [32]. A global data synchronization network (GDSN) holds the master data that is fundamental and critical to all business systems and uninterrupted flow of goods throughout the Supply Chain. Sharing data effectively and efficiently is reliant on access to precise data definitions by all partners, data accuracy and agreement on the process used to support the exchange of data between trading partners [33].

In a complex and competitive business environment, the function of the warehouse in a supply chain has broadened to handle high product varieties and demanding requests for customized value-added services and timely delivery [34]. Warehouse management systems (WMS) plays a significant role, connecting the areas of storage, material flow, production, record keeping, has a significant impact on business operations, and can be of an important competitive advantage. The study by [35] discusses the optimization of warehouse management in the assembly and distribution company and introduces an automatic identification system including barcoding to optimize the WMS in which production and distribution processes are controlled by information processes that manages the flow of material increase efficiency and quality of business activities while reducing costs. The Figure 2 outlines some of the key processes in warehouse operations and how barcoding systems can be a good enabler.
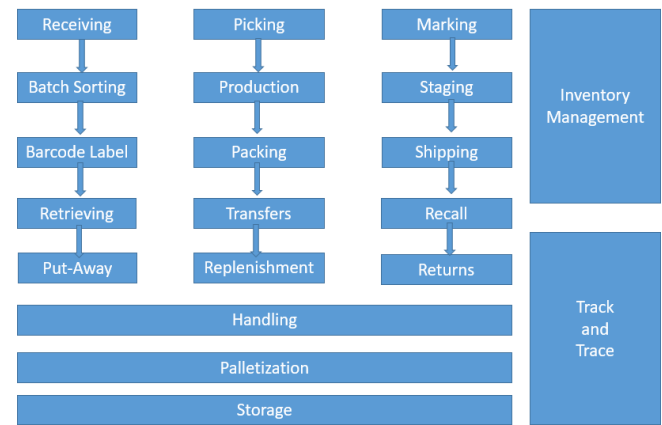


Figure 2 : Key Warehouse processes involving barcoding.

Barcode based WMS plays significant role in the management of stocks for the organizations. As shown in Figure 2 , WMS includes several processes in the Warehouse and below are some common activities:

a) Unloading of vehicles and receipt of goods from a truck or container into a warehouse after checking the physically received goods with the purchase order and specifications. If the products were received from a barcode compliant supplier, every box would have a barcode.

b) Sorting of the products based on the batch number which also signifies expiration date are important parameters in healthcare supply chains.

c) Put-away and storage - After the goods are received, the next process is put-away, an activity of placing goods in the storage area. After the goods are received, a barcode label is printed with the expiry date, containing the product, quantity, and location of the goods. The next step is scanning a barcode on the goods that will be stored and put the goods in the appropriate place.

d) Picking is the activity of preparing and picking up goods in the warehouse according to the picking list generated for a specific sales order.

e) Packing is the process to pack the goods that are intended to make the goods safe during the shipping process.

f) Marking is activity encompasses labeling items of an order into a shipping unit. Thus, pallets are identified by means of the SSCC barcodes that identify the shipper while the consignee labels identify the final destination.

g) Transfer between locations: this process encompasses several different activities, whose aim is to change the location of labeled cases/pallets within the warehouse.

h) Palletization – The shipper cartons are assembled on pallets for ease of handling and pallets are moved from the staging area and loaded into an outbound vehicle.

i) Outbound quality control is carried out for the goods picked according to the picking list before the goods are actually out from the warehouse.

j) Loading of outbound vehicles is carried out by scanning of the barcode on the packing list, which contains detailed list of products and quantities of goods to be sent to the destination.

k)Stock Take - is an activity of checking the whole inventory stock in the warehouse, in which product barcodes are scanned to check the physical count of products in stock.

During these transactions, the quantities of the related products are automatically updated in the system or displayed for the user's reference. Barcode scanning at various stages transmits data or information to the WMS database and this vast amount of transactional data gives a huge opportunity to utilize data Analytics / BI to transform the data into business insights or opportunities. The decision making is one of the key processes involved in efficient warehouse operation to execute customer orders respecting the timing , customer demands , cost effectiveness and flexibility [34].

Data **analytics** and visualization allows a "360 degrees" view of the operations and customers that often assist managers to optimize, direct and automate their decision making to successfully achieve their organizational goals. Predictive analytics can help in transforming operational data into strategic information, which can be potentially utilized in decision making to gain competitive advantage [37].

Many organizations have invested in data analytics to streamline operations and improve processes, but such implementation is often complex and it is not very easy to obtain intelligent and effective business decisions unless a right system is implemented. With technologies like barcoding and E-commerce, the data is growing in volume, variety and velocity. Business analytics have been playing a key role in transforming data to provide business insights that help to solve problems and achieve long-term success by timely decisions and performance monitoring. To ensure adequate information standardization and sharing between the warehouse processes, the data repository has to be designed to derive relevant information to optimize the warehouse management. This data is a huge asset to the organization to transform into useful business insights and performance improvement using business analytics or BI. Today, the world contains a massive amount of digital information and this kind of large amounts of data can be used by the industry in decision-making to generate value for the companies gaining insights and transform data into business opportunities. [38]. Study by [39] also confirm that the data analytics has significant positive association with **operational performance.** In an exploratory study on use of analytics in Indian enterprises by [40], it was found that an effective understanding of **analytics as a tool for decision making.** The results of study by [41] suggest that

big data analytics capability has a positive and significant effect on **supply chain agility** , supply chain performance and hence enhances competitive advantage.

Study by [42] confirm that the analytics and BI systems have a significant positive impact on the business process performance and organizational performance.  The study showed enhanced profit margin, improved competitive advantage, increased sales, better productivity and cost reduction that can lead to **sustainable economic growth.** An increase in levels of data and technological capabilities is redefining **innovation, competition, and productivity** as stated by [43] that identifies how big data improves functional capabilities.  The BI tools and dashboards should provide an accurate & timely information in a form easy to interpret and take action to improve competitive advantage of the organization [37].   A study related to supply chain analytics by [44] find that data management resources play a key role in supporting BI based supply chain planning and performance management resources. BI dashboards have evolved from performance monitoring to more advanced analytical purposes, with new features such as scenario analysis and drill-down  [45] . Scenario analysis are very helpful for businesses operating under uncertainties, while drill-down  provides flexibility to use dashboards for overviews as well as details. Dashboards help in the performance management and could significantly reduce the information overload issues. Using the BI tools, the complex corporate level data can be presented professionally for various reporting needs like business Performance Management and Scorecards.

## III.  OBJECTIVES OF THE STUDY

The research will examine the importance of barcoding and business intelligence systems in improving supply chain efficiency. The paper introduces terminology used, establish a general criteria system of traceability in case of warehouse processes and provide an overview how how the data captured through the barcoding in the ERP / WMS be used to increase the operational efficiency.

This study had focused interviews with the industry professionals probing to identify perceived business value of dashboards in **performance management.** During this study, the researchers tried to identify the challenges as faced by the decision makers and then tried to get some ideas from the professionals to find some solutions.

The purpose of this explorative study was to investigate how barcoding, its associated data and BI /data analytics can help the business managers to effectively improve decision-making, speed and performance. The results will help managers and business owners in putting place strategies to utilize barcoding and data analytics better to understand their business and improve the agility and competitive advantage.

## IV.  RESEARCH DESIGN

There is not much research undertaken in industrial barcoding implementation and its effective use in healthcare supply chain management in India. To better connect barcoding processes, supply chain data and its use to the business managers, we present a structured review of academic literature that addresses these areas independently. Therefore, our research fills this gap, by investigating the implementation and use of best practices in implementation of barcoding and BI in warehouse and supply chain management, and understand challenges faced. This research utilizes Qualitative approach to describe the processes , terminology used and key common barcoding processes in a WMS system - such as goods receiving, put-away , storage, inventory control , order processing , picking, outbound, loading and tracking to improve efficiency in the warehouse. The aim of this paper was also to identify how the huge data captured through barcoding system throughout the supply chain are used in BI / dashboards for decision-making, performance management, communication, and analysis.

The recent literature on the subject is reviewed to provide a taxonomy framework and this paper points to an urgent need to bring the efforts closer in a collaborative way for more intelligent use of data analytics in SCM to use the huge barcode transaction data for decision making and performance management and to help organization in enhancing its competitive advantage. Considering the exploratory nature of the research, we have adopted a qualitative approach to data collection and analysis. Based on an extensive literature review, the researchers have developed a semi-structured questionnaire for in-depth interviews of 12 supply chain professionals who have been widely using WMS and dashboards for decision making in various functional areas.

Interviews with senior management professionals were focused on utilization of vast amount of data for improving the operational efficiency and achieve economic sustainability. The interview method allowed two-way communication that helped in seeking more detailed and in-depth information through open-ended questions. Focus of these interviews was to analyze how the data is utilized for demand planning, Customer satisfaction, optimization, predictive analytics and frugal innovation.

Each interview lasted between 60 to 90 minutes and this method allowed two-way communication that helped in seeking more detailed and in-depth information through open-ended questions. Focus of these interviews was to analyze current systems, integration with Enterprise resource planning (ERP) & other data and challenges to meet the end user requirements. Interviews also focused to study the impact of size of the organization, user level, and user knowledge and data quality.

The research hypothesis were as follows:

H1: Barcoding systems positively impact speed and efficiency of warehouse management.

H2: Barcoding and data analysis impact the traceability of products

H3: BI dashboards impact quality of data driven decision making

H4: BI dashboards impact supply chain performance management.

## V.  RESULTS AND DISCUSSION

The researcher focused the interview questions in these 2 key areas to consolidate findings and draw the pattern to understand the role of BI dashboards in decision making and Organizational performance management. We started exploring the key supply chain areas and how the barcodes were used for improving speed, efficiency and traceability. Below were some excerpts from the interviews:

"We implemented barcoding in our warehouse management recently. Barcodes have extremely helped us in improving the speed of receiving, accurate product picking, packing and dispatch. The automation in our receiving and packing lines have improved the operational efficiency as well as accuracy. The system helps us to accurately identify exact batches and relevant quantity received / scanned," mentions a Quality control officer.

"Our warehousing management system is an integral part of the ERP and equipped with barcoding. We use the scanners for data capture for every transaction. This helps in maintaining a complete link and helps us in track and trace throughout the complex supply chain involving numerous batches and products." Mentions a quality manager "Before barcoding, we used to face several challenges in our daily operations and periodic stock take often used to be a pain. With the barcodes, it is now very simple task and we can generate the accurate stock reports with right locations. We are working on BI tools to see the inventory levels in a visual dashboard," states an Inventory Controller

"As many of our contract labor are not very good in English reading, there used to be a difficulty. With the barcode scanners, the same persons can now easily carry out the warehouse operations by simple click and scans. This has helped us to substantially reduce the training time and have greatly reduced the human errors," mentions a warehouse manager

"As our business is seasonal, predicting demand is helpful to prioritize and optimize the warehouse space," says a warehouse manager working in a pharmaceutical

warehouse. "Our BI consultant is developing a dashboard to visualize our expected future goods movement and warehouse utilization and we very much look forward to it"

"For high speed assembly line, we have integrated high speed barcode scanner that helped us to complete a large complex project ON TIME with GS1 data matrix barcodes, batch numbers and expiry dates on huge number of packed boxes at amazing speed. The packing belt included a rejection mechanism to move boxes with non-readable barcodes into a reject bin, which ensured a high level of barcode quality in approved boxes," says a senior manager of a pharma company.

"With the integration of barcodes in our warehouse management system, we can now easily trace the product right from receiving from our supplier till the dispatch and we can exactly identify which batch is used in which carton, that helps a lot to identify or locate batch data for a particular country or customer in case of any batch issues. Such features are extremely useful in case of any product claims and a proactive analysis helps to avoid any product recalls," say a Quality Director.

"We use barcoding system to scan all pallets or boxes into shipping containers and this helps us to easily communicate with our global customers and the receiving team from our customer often appreciate us for a clear information and data that helps them in improving their operational efficiency and accuracy," says a Logistics manager.

"The barcode scanning generates huge amount of useful data and this is extremely helpful for statistical quality control and the patterns that can assist us in focusing on specific areas that we need to focus for ensuring continual improvements in speed and quality" states an Operations manager.

"With the barcoding integration, we can generate a vast amount of data that helps a lot in getting precise information about past that we use for our forward planning and this has greatly enhanced our operational efficiency" states a planning manager.

"With our integrated system, we scan the outbound cartons before loading them into shipping containers. This not only gives us an exact container content list, but it also gives a complete sequence and helps un in tracking the products throughout the supply chain" mentions a global supply chain manager.

"The barcoding system has improved the efficiency as well as agility of our operations, which is extremely important while handling complex supply chain. With simple scanning, we are able to maintain a complete track and trace without compromising the speed – rather we have been able to enhance our operational speed and accuracy," adds an Operations Director.

We next tried to explore as to how data analytics / business intelligence (BI) help organizations to transform the captured data to achieve the business purpose.  Most users stressed that the BI dashboard help in decision making, performance management, KPI monitoring and reporting. Below are some excerpts from the interviews:

"We have developed interactive BI dashboards using heat maps and various graphics that assist us in various decision making and visualizing the stock levels and density / distribution". Says an Operations manager.

"The barcoding system and huge amount of live data , gives a lot of opportunity to manage the warehouse more efficiently and gives us the ability to track and trace products at batch levels which used to be a very difficult task in past" says a pharma supply chain manager.

"We need to have the exact batch details of every product and its expiry date for many decisions and visual dashboards with drill-down options makes our lives easy" says a warehouse manager working in a pharmaceutical warehouse. We can easily see a broad level overview with the warehouse utilization and then drill down to details based on a particular order or category.

"The dashboards gives us flexibility to view the historic trends and also look at current data to do our planning. BI has greatly helped us to save our time and enabled us to deliver right products on right time to our esteemed customers and having timely quality information is critical in today's uncertain business environment," Says a planning manager responsible for the supply chain planning.

"The self-service BI feature allows me to customize dashboard to my needs," says one of the BI users working in a pharmaceutical warehouse operation.

"Quality of data is equally important and with integrated barcoding, we now have access to high quality data that enables us in various decisions in terms of product quality". States a Quality Director.

"We analyze of inventory data to understand the seasonal fluctuations and to identify any business opportunities based on historic data as well as market demand intelligence data," says a senior marketing manager of a pharma company.

"I use BI to monitor the daily production levels at our remote site & that helped me a lot to save frequent travel," says a senior manager. "We used an automated packing system, integrated with high speed scanner and the BI dashboards really helped us in terms of performance management and KPI monitoring. With a focused monitoring, we managed to complete the complex project ON TIME".

"We used to use many Excel spreadsheets for our operational but KPIs and BI dashboards has simplified that so much, that we can spend lot of our time to work on the

actions. The interactive feature of Power BI is just amazing and it gives us an opportunity to have a complete 360-degree view of our value chain," states a senior manager in a pharmaceutical company.

"Tracking batch details of products inside millions of cartons accurately is a huge challenge and our barcode integrated warehouse management system has indeed helped us in this greatly. Today, we are able to have a complete track and trace by just few clicks with very high accuracy levels," mentions a warehouse quality control officer.

"We have adopted the GS1 standards and the barcoding has enabled us to monitor and measure stock easily and accurately and this has greatly enhanced our Inventory management. With our business intelligence tools, we can easily relate the product arrival dates and plan our packing as per required delivery dates or demand," states an Inventory Controller responsible for packing of wide range of healthcare products.

"We have been using various BI dashboards that assists us in various operational decisions and we have realized that purpose of data analytics is much beyond analysis, monitoring, and reporting. We are building dashboards that assist our team to decide what to pack – when to pack and such a data driven system has enabled us to cater to a wide range of projects efficiently," says an Operations Director.

## VI.  MANAGERIAL IMPLICATION

Barcoding systems plays an important role in enhancing speed , efficiency , accuracy and traceability throughout the supply chain and generates vast amount of valuable transactional data. BI dashboards indeed play increasingly important role in decision-making, and organizations will see more opportunity for exceptional business impact. Based on the overall study, the researcher suggests below guidelines that will be very useful to implement barcoding and using the captured data for BI / data analytics system to help them in effective and efficient business operations:

a) Use appropriate, universally tested barcoding standards and ensure that the entire process flow is designed for effective use of barcoding through use of right hardware and software.

b) Ensure that items are uniquely identified using GTIN to help tracking the transactions accurately.

c) Plan to share the master data of various products and its key attributes using a shared database.

d) Ensure that the system provides a well-structured traceability system to monitor effectively

e) Use auto identification using high speed scanners or imagers , to enhance efficiency and accuracy

f) Data visualization has impact on speed & quality of decision making, so dashboard design should use right visuals and right locations.

g) To focus on effective decision-making, dashboards should be designed to be simple for use and effective decision-making.

h) The quality and reliability of the information is extremely important, so ensure right infrastructure, integration, speed and well trained employees.

## VII.  CONCLUSIONS

This study explores how technologies like barcoding and business intelligence assist in enhancing healthcare supply chain performance. The finding support existing research that barcoding offers many advantages including speed enhancement, efficiency improvement, traceability, efficient decision making in managing supply chain operations. The implementation of barcodes and business intelligence can speed up the delivery of information throughout the supply chain and also help in traceability features that offers a key competitive advantage.

This study was carried out to understand how BI dashboards helps organizations to handle the growing complexity of data, information, and business decisions. The key benefits of BI were identified as improved data driven decision-making and resource optimization. The research revealed that dynamic and visual dashboards provide useful business insights to the decision makers and help managers to take timely and effective business decisions.  Indeed, BI makes the task of transforming huge and complex data into Actionable Information easier. Effective use of BI can greatly help professionals to make improved decisions & hence BI has become one of the key pillars of information ecosystem in today's world. However, this is achievable when the dashboards are well designed using the right BI capabilities and used by quality BI users and decision makers. This study presents an opportunity to look into how BI dashboards can be developed for effective decision making that can lead to improved business performance.

The study will contribute to literature in the area of barcoding and effective use of its generated data for data analytics /BI and will be of value to both the academic and business professionals. The findings and suggestions would help professionals to proactively address some of the challenges for a smooth BI implementation and maximize the benefits of BI dashboards. This study also contributes to provide set of guidelines for effective BI dashboard development and may be relevant for supply chain professionals and decision makers. Based on the various discussion, all hypothesis are accepted. The main contribution is made to the resource-based view theory, which according to supply chain visibility can be seen as

both a strategic resource and a tool for efficiency optimization.

## VIII. LIMITATIONS AND FUTURE RESEARCH

Being a descriptive study, there was no quantitative analysis involved and future research shall validate these based on a survey mechanism using a wider range of industries and end users of BI. The study opens up a number of new directions and the results can be further expanded by interviewing supply chain management professionals globally. There has been comparatively lower focus on Radio Frequency Identification (RFID) in this study and considering rapid advancing technology, further studies in and new technologies is recommended.

## REFERENCES

[1] Kolyesnik, Olena. Decision analysis process model for alternative technologies evaluation within warehousing applications. Doctoral dissertation, Wichita State University, 2008.

[2] Locatelli, Paolo, Federica Cirilli, and Antonio Jacopo Scardigno. "An integrated digital solution to improve the governance and the monitoring of logistics for medicines and medical devices."

[3] Silalahi, Rudy Vernando. "Designing a computerization management production system in PT Akrilik Kurnia Kencana using barcode." IOP Conference Series: Materials Science and Engineering. Vol. 909. No. 1. IOP Publishing, 2020.

[4] Istiqomah, Nadya Amanda, et al. "The Implementation of Barcode on Warehouse Management System for Warehouse Efficiency." Journal of Physics: Conference Series. Vol. 1573. No. 1. IOP Publishing, 2020.

[5] Allio, Robert J. "Strategic thinking: the ten big ideas." Strategy & Leadership (2006).

[6] Negash, Solomon, and Paul Gray. "Business intelligence." Handbook on decision support systems 2. Springer, Berlin, Heidelberg, 2008. 175-193.

[7] Işık, Öykü, Mary C. Jones, and Anna Sidorova. "Business intelligence success: The roles of BI capabilities and decision environments." Information & management 50.1 (2013): 13-23.

[8] Sparks, Betsy H. The relationship of business intelligence systems to organizational performance benefits: A structural equation modeling of management decision making. Diss. Capella University, 2014.

[9] Provost, Foster, and Tom Fawcett. "Data science and its relationship to big data and data-driven decision making." Big data 1.1 (2013): 51-59.

[10] McCathie, Luke. "The advantages and disadvantages of barcodes and radio frequency identification in supply chain management." (2004).

[11] Gupta, Rajeev, and Prachi Rastogi. "Barcode for Retail Store Operations-The Perfect Tool at Low Cost."

[12] Arendarenko, Ernest. "A study of comparing RFID and 2D barcode tag technologies for pervasive mobile applications." Master, Department of Computer Science and Statistics, University of Joensuu (2009).

[13] Främling, Kary, Mark Harrison, and James Brusey. "Globally unique product identifiers–requirements and solutions to product lifecycle management." IFAC Proceedings Volumes 39.3 (2006): 855-860

[14] GS1, "Healthcare GTIN Allocation Rules," 2013.

[15] Beckman, Catharina, and Emma Bernander. Traceability in Legal Pharmaceutical Supply Chains-ensuring safety and quality of prescribed medicinal products. MS thesis. 2015.

[16] Bansal, Dipika, et al. "Anti-counterfeit technologies: a pharmaceutical industry perspective." Scientia pharmaceutica 81.1 (2013): 1-14.

[17] Mishra, Dharmendra Kumar, et al. "Traceability as an integral part of supply chain logistics management: an analytical review." arXiv preprint arXiv:1811.06358 (2018)

[18] McFarlane, Duncan, and Yossi Sheffi. The impact of automatic identification on supply chain operations. University of Cambridge, Department of Engineering, 2003.

[19] Istiqomah, Nadya Amanda, et al. "The Implementation of Barcode on Warehouse Management System for Warehouse Efficiency." Journal of Physics: Conference Series. Vol. 1573. No. 1. IOP Publishing, 2020.

[20] Semianiaka, Natallia, and Ekaterina Silina. "The role of global data identification standards for supply chain visibility: the case of GS1." (2012).

[21] Burbano, Angelica. "Modeling the adoption of identification standards within the healthcare supply chain." (2012).

[22] Gupta, Priyanka, and Himalaya Kaul. "Traceability Technologies across the Food Value Chain." International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS) 6.1 (2017): 6-9

[23] GS1, "GS1 Standards Document Global Traceability Standard for Healthcare," 2009.

[24] Aung, Myo Min, and Yoon Seok Chang. "Traceability in a food supply chain: Safety and quality perspectives." Food control 39 (2014): 172-184.

[25] Tarjan, Laslo, et al. "A readability analysis for QR code application in a traceability system." Computers and Electronics in Agriculture 109 (2014): 1-11.

[26] Thanapal, P., J. Prabhu, and Mridula Jakhar. "A survey on barcode RFID and NFC." IOP Conference Series: Materials Science and Engineering. Vol. 263. No. 4. IOP Publishing, 2017.

[27] Sadaf Zaidi & Sekar Widyastuti Pratiwi, "Meningkatkan Traceabilitas untuk Kinerja Yang Lebih Baik," Misi, pp. 1–6, 2016.

[28] K. Krivács, T. Hartványi, and C. Tápler, "Basic requirements of material traceability in warehouses," pp. 849–855, 2010.

[29] Lovis, Christian. "Traceability in healthcare: crossing boundaries." Yearbook of medical informatics 17.01 (2008): 105-113

[30] Jayaraman, Raja, Fatima AlHammadi, and Mecit Can Emre Simsekler. "Managing Product Recalls in Healthcare Supply Chain." 2018 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM). IEEE, 2018..

[31] Lehlou, Nabil, et al. "A levels, readiness, and impact evaluation model for GS1 adoption in healthcare." IIE Annual Conference. Proceedings. Institute of Industrial and Systems Engineers (IISE), 2011.

[32] Ziadlou, Dina. "Using GS1 for health supply chain in disaster management." International Journal 1.2 (2013)

[33] Popa, Virgil, and Mircea Duica. "Global Standards and Best Practices for Supply Chain Information Alignment in Consumer Goods and Retail." The European Conference on Information Systems Management. Academic Conferences International Limited, 2010.

[34] Lam, H. Y., et al. "A knowledge-based logistics operations planning system for mitigating risk in warehouse order fulfillment." International Journal of Production Economics 170 (2015): 763-779.

[35] Stopka, Ondrej, and Vladimír Ľupták. "Optimization of warehouse management in the specific assembly and distribution company: A case study." NAŠE MORE: znanstveni časopis za more i pomorstvo 65.4 Special issue (2018): 266-269.

[36] Mishra, Himani, and Prateek Maheshwari. "Achieving sustainable development goals through Fourth Industrial Revolution: An Indian perspective." Indian Journal of Commerce and Management Studies 11.2 (2020): 63-75.

[37] Bose, Ranjit. "Advanced analytics: opportunities and challenges." Industrial Management & Data Systems (2009).

[38] Ye, Qinyan, and Robi Obotaira Morro. "From Reporting to Analytics: Leveraging Business Intelligence in enabling organisations' transformation towards becoming data-driven." (2018).

[39] Gupta, Manjul, and Joey F. George. "Toward the development of a big data analytics capability." Information & Management 53.8 (2016): 1049-1064.

[40] Xavier, Maria Joseph, Anil Srinivasan, and Arun Thamizhvanan. "Use of analytics in Indian enterprises: an exploratory study." Journal of Indian Business Research (2011).

[41] Dubey, Rameshwar, Angappa Gunasekaran, and Stephen J. Childe. "Big data analytics capability in supply chain agility." Management Decision (2019).

[42] Elbashir, Mohamed Z., Philip A. Collier, and Michael J. Davern. "Measuring the effects of business intelligence systems: The relationship between business process and organizational performance." International journal of accounting information systems 9.3 (2008): 135-153.

[43] Mazzei, Matthew J., and David Noble. "Big data dreams: A framework for corporate strategy." Business Horizons 60.3 (2017): 405-414.

[44] Chae, Bongsug, David Olson, and Chwen Sheu. "The impact of supply chain analytics on operational performance: a resource-based view." International Journal of Production Research 52.16 (2014): 4695-4710.

[45] Velcu-Laitinen, Oana, and Ogan M. Yigitbasioglu. "The Use of Dashboards in Performance Management: Evidence from Sales Managers." International Journal of Digital Accounting Research 12 (2012).