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No More Missing Inventory: Blockchain and RFID Technology Applications within the Retail Inventory Management System

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**NO MORE MISSING INVENTORY:
BLOCKCHAIN AND RFID TECHNOLOGY APPLICATIONS WITHIN THE RETAIL
INVENTORY MANAGEMENT SYSTEM**

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ABSTRACT

Over the last two years blockchain technology has presented itself as a potential digital transformation that could disrupt and revitalize many business models. However, this digital transformation is still new and many companies grapple with possible applications of its theoretically sound benefits. Academic research is scarce and often limited to high level perspectives on how blockchain can benefit businesses in general. The time is right for exploring specific applications of the technology. This research considers how the digital transformation to blockchain could impact inventory management practices within the retail industry. The research relies on data collected through phenomenological interviews with management personnel of three clothing retail store franchisees.

**BLOCKCHAIN AND RFID TECHNOLOGY
IN THE NEWS**

Technology has helped business professionals make significant strides across all dimensions of supply chain management. Blockchain technology has entered the business domain and is showing tremendous promise in pushing supply chain management practices to the edge of a new information-sharing frontier. In a recent article from Forbes, IBM executives revealed that their blockchain ‘Food Trust’ system allows food processors, for example, Nestle, Kroger, and Tyson, to track produce from farm to the store shelf (Stanley, 2018). The system offers a variety of services to encourage its usage - securing data and access rights, integrating blockchain with current platforms, and finding a business model that benefits all parties involved. Brigid McDermott, vice president of IBM’s “Food Trust” reported that blockchain will have a significant impact on the food industry.

Supply chain professionals and academic scholars have begun to explore the various applications of blockchain technology across several business disciplines. However, many basic knowledge gaps exist. This research paper explores the gaps and contributes to the literature on how blockchain can assist retail operations and customer service. Existing research is limited primarily to conceptual studies. Further empirical inquiry is needed. In addition, current literature focuses on the overall benefits of blockchain in supply chain management (SCM) practice, but fails to pursue an understanding of the potential negative effects of blockchain on individual supply chain partner operations. This study is an effort to analyze the benefits and consequences of utilizing blockchain technology in a retail inventory management process through interpretive analysis of interviews conducted with professionals who work within retail operations of a national junior clothing retailer.

Clothing retailers' inventory management systems can be challenged in several ways, for example, keeping real-time records of product in route from the DC to the store, distinguishing product within the unloading process from product received and verified, maintaining visibility of SKUs during replenishment of the sales floor each night to processing damaged goods and even identifying store-specific trends.

Figure 1 illustrates a flowchart pertaining to common activities and processes pertaining to inventory flow within retail operations. While not all retail operations are identical there are many basic activities and processes that appear in some form within most operations. Prior to receiving freight at a retail store, the shipper and carrier interact to arrange freight pickup and transport. For some organizations, an advanced shipment notification (ASN) may be conveyed to the receiving party immediately upon loading and shipment. ASNs provide receiving departments opportunities to better plan for the unloading, disposition, and movement of the inbound freight prior to the freight actually arriving. This will provide benefits in labor allocation and critical product expediting upon receipt. Receiving entails the unloading and checking in of the freight, managing product discrepancies in the overages, short and damages (OS/D) rework area, and circulating received freight through value added service departments prior to stocking retail shelves. However these processes are often not optimized and could stand improvement in many cases.

Blockchain may be leveraged to establish improved documentation communication between distribution centers and retail stores and provide up-to-date inventory records. This paper highlights the possibilities of utilizing blockchain technology to improve retail operations and customer experiences. Moreover, major practical pitfalls associated with this new technology are discussed.

In this article The current state of the literature is discussed first. We then introduce the research

methodology and follow with a detailed discussion of the findings. Guidelines for practitioners and future research agenda for academics are offered last.

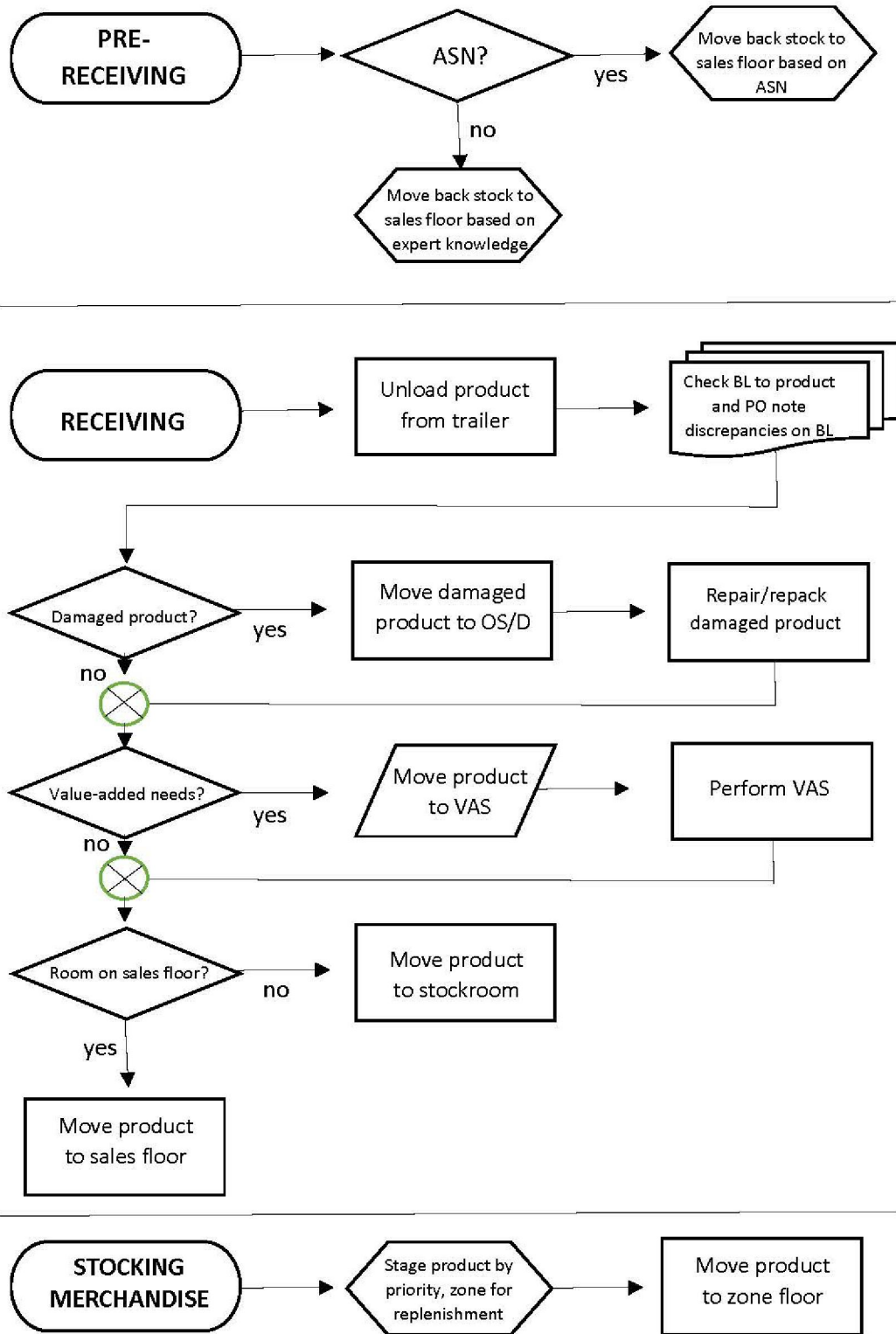
WHAT IS KNOWN ABOUT BLOCKCHAIN AND RFID TECHNOLOGY

Blockchain technology operates on a decentralized peer-to-peer basis, where it is impossible to artificially edit any information because of its unique heavy encryption and required verification protocol from all parties involved (Douaihy, 2018). Since the blockchain is decentralized and encrypted it has been deemed essentially "unhackable," ensuring security while keeping every transaction and document traceable to the original source. Fraud is prevented and identified by attaching a signature to each edit made by a user and making it public (Felin & Lakhani, 2018). Additionally, blockchain's ability to upload and share documents instantly minimizes courier costs for late paperwork. The ability to view the critical supply chain documentation from the beginning of materials or product movement to its end, and nearly instantaneously, would allow companies to verify goods, documentation, and cash flows while anticipating issues that might affect a company's part of the process and prepare for such issues (Dobrovnik, et al., 2018; Lindell, 2018). Moreover, it allows for identification of all the parties involved up and down the chain, allowing the channel captain to determine the level of risk at each node and link in the chain.

As blockchain becomes more widely accepted and less expensive practice, it is likely to trickle down through all sizes of companies and potentially include everyday consumers. Whether it will be widely accepted is still up for debate (Douaihy, 2018). Blockchain works best when all stakeholders involved in the supply chain use it, otherwise, non-conformity results in gaps in the data information chain.

How Could Blockchain and RFID Technology Affect the Supply Chain?

FIGURE 1
RETAIL OPERATIONS RECEIVING AND STOCK MOVEMENT



Sissman and Sharma (2018), discuss the positive and negative possible effects of blockchain implementation. Blockchain provides visibility and insight with respect to products and materials procured. For example, companies could confirm that raw materials and products are coming from ethical sources. Producers and end-users could have access to real-time updates regarding the production of their goods. Companies would be better equipped to proactively respond to shortages when manufacturing of their materials falls behind, and consumers could know ahead of time if a product will be out of stock in a specific retail store. Information could be made available to the public from the moment the supply chain begins until the end, making demand and inventory management less of a guessing game. Consumers could have access to the blockchain from their phone or computer making information critical to a customer's needs and wants immediately available. With the same touch of a button, consumers would be able to verify that what they are purchasing is verifiably organic, non-GMO, fair-trade, or made in a country of their choice. Investors would be able to use the blockchain to research companies' history, financial statements, and whether the company's current practices align with their own.

While the transparency throughout the supply chain may be valuable for some stakeholders within the supply chain and possibly for consumers and major manufacturers, such disclosure and visibility of proprietary information and data can become an issue if competitors have the same access because it limits a company's competitive edge. One proposed idea to safeguard a firm's competitive advantage is a private blockchain and "sharding" (Curran, 2018). Sharding breaks up the blockchain into shards or pieces that when put together form a complete blockchain. As number of transactions grows, the network bogs down and processing and recording of each transaction takes exponentially longer time. Breaking one blockchain into smaller "shards" limits this exponential growth of processing time. Related

to speed is scalability. If the speed of the network can be addressed, then larger more computationally taxing transactions can enter the network. Lastly, sharding allows companies to keep certain information public while proprietary and other sensitive information can remain private. In other words, some shards can be on a public blockchain to benefit consumers and business partners. Sensitive data and specific transactions can remain on a private blockchain. Speed, scalability, and visibility are all of concern when addressing retail inventory management practices.

While out of the scope of this research, blockchain has also become an ideal platform for cryptocurrencies. For example, Bitcoin transactions are recorded by all stakeholders from the buyer to seller to the credit card company involved in making the initial purchase. This same transaction method could be used in business-to-business sales to prevent fraudulent transactions. From a retail customer focused perspective, such digital currency through blockchain could be adapted for retail point of purchase currency exchange between consumer and retailer.

Incidents have been reported of fraud with cryptocurrency transactions being hacked, causing concern about the regulations surrounding blockchain (Russolillo & Jeong, 2018). So far there have been over 50 reports of hackings with millions of U.S. dollars lost in cryptocurrency. The hacks that have occurred are mostly focused on bitcoin and ethereum transactions because they are the dominant cryptocurrencies and there is a significant lack of regulations surrounding them. Cryptocurrency exchanges involve trading fees and store currencies making exchanges an easy and low-cost investment for hackers. This creates concern to many potential investors of blockchain for obvious reasons, will their business transactions be safe if blockchain is widely adopted? As of now there are no regulated security measures in place to protect bitcoin exchanges.

One of the many benefits to the blockchain is the inability to alter or change data/documents once posted and verified. This idea is an ensured way to prevent laundering and fraud; however, if confidential information is accidentally made public there is no way for it to be removed as it is a permanent ledger. All data and document changes in a blockchain system become shared knowledge with designated blockchain members (Niranjanamurthy, Nithya & Jagannatha, 2018). The possibility of private information being posted is also a concern of many companies. There are large cost savings in the long-run (Felin & Lakhani, 2018), but the initial cost of set-up and training will be expensive. These factors, plus blockchain being a new technology, will make companies hesitant about fully accepting it right away.

How Could Blockchain and RFID Technology Benefit the Retail Industry?

Blockchain technology implemented on a mass scale could provide outcomes beneficial to the consumer (Laposky, 2018). All stakeholders (consumers, suppliers, credit card companies) would have a restored sense of trust by being granted the same transaction information simultaneously. Consumers making purchases through the blockchain will benefit from instantly accessing proof of purchase documents. The extra time that was originally spent tracking down these items and transferring them from person to person will result in money that suppliers can put towards decreasing retail prices and increasing stakeholders' value. Once instant updates throughout the supply chain are made available it opens doors to improving individual processes along the supply chain. One of these processes is order fulfillment. Companies involved in business-to-business transactions will be able to communicate product fulfillment needs and reduce lead times by sharing information instantly.

With the visibility that blockchain provides, retailers and consumers will be able to see exactly where their products are sourced (Radocchia, 2018).

Increasingly, companies have outsourced manufacturing to Asian countries, where cheaper labor is available. However, in some instances the low cost labor is associated with unethical and inhumane labor practices. Consumers worldwide are taking notice and are increasingly switching to locally produced goods with origins that are easily verifiable. Blockchain can provide such visibility and source verification at a global level for consumable products. For example, during Shanghai Fashion Week, in collaboration with a technology provider, one designer placed microchips (i.e. RFID tags) in each piece of clothing and recorded information pertaining to the clothing on the designer's blockchain (Sharma, 2018). Fashion show audience members, utilizing their mobile phones, were able to access the designer's blockchain and confirm that a garment within the designer's collection was legitimately produced by the designer or was a counterfeit garment.

Recent advancements in other technologies may be integrated with blockchain to further transform retail distribution (McCrea, 2018). Online retailer Amazon uses robots to locate and move bins of products directly to an order-filler's work station. (Wingfield, 2017). The improvement has enabled order fulfillment efficiencies and increased the number of items made available for Amazon Prime's two-day shipping. In the background blockchain records where the inventory is located at any given moment within the process and provides an immediate detailed track of the product's movement through Amazon's internal and external supply chain.

Technology exists to improve inventory management without the use of blockchain. For years, retailers have utilized radio frequency identification technology (RFID) and tags to help maintain inventory integrity within the warehouse and for some high value products within the retail sales floor (Hardgrave, Goyal & Aloysius, 2011). Sensors are placed at different points throughout the stock room and sales floor so that items are tracked whenever

they pass a certain point (RFID tag readers) and recorded. Opportunities exist for the integration of RFID and blockchain technology to improve inventory management and visibility for specific stakeholders.

METHODOLOGY

Sample

Management and front-line employees of three leading clothing franchises were interviewed to learn about their retail-floor and stockroom inventory management issues, their understanding of blockchain technology, and their perceptions of how such technology could improve their current inventory management processes. Four store managers, three full-time stock associates, and one part-time sales floor associate were interviewed. Their retail industry experience ranges from 2 to 15 years. More specifically, the employees were asked about their view of general inventory management practices, using their current stock replenishment information system, where they believe there is room for improvement, and their initial opinion of

the implementation of blockchain technology in retail-level inventory management.

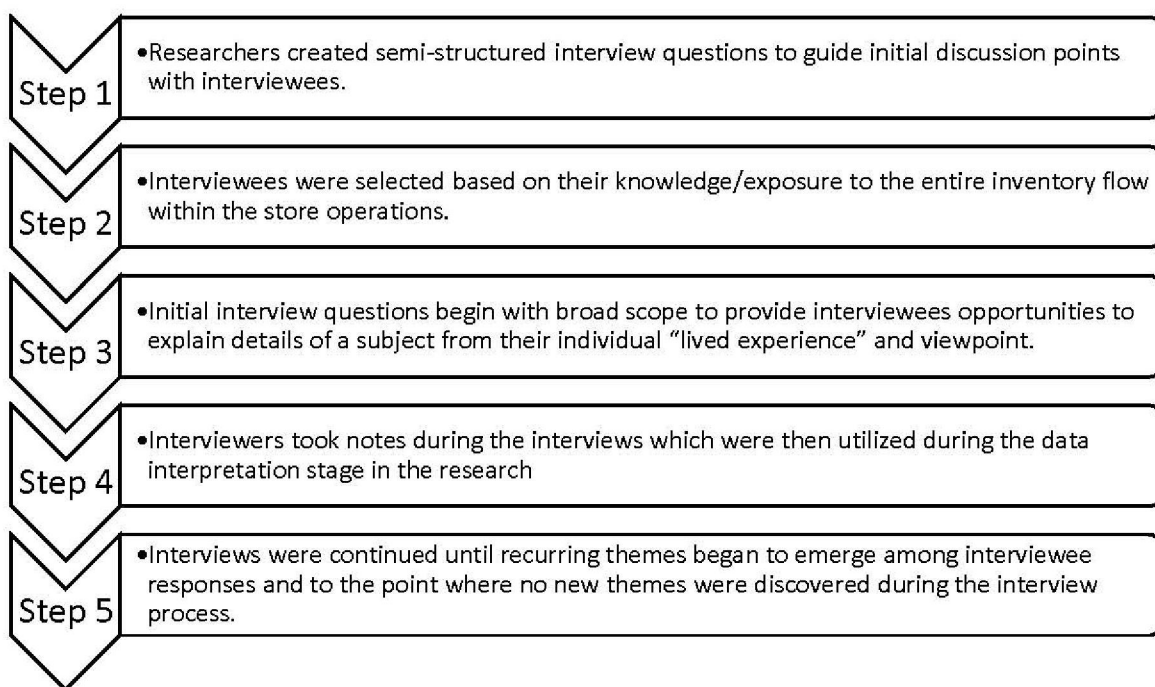
Data Collection Method

In order to develop and present a richer perspective on the topic we utilized an in-depth interview technique (McCracken 1988), which allows for a deep understanding of a phenomenon by interviewing relevant employees. This interpretive research methodology provides insights into the “lived experiences” of interviewees. By including management, stocking and sales floor personnel the data provides insights from multiple perspectives within retail operations.

Figure 2 provides the 5-step process taken to conduct phenomenological interviews with each interviewee.

Researchers began each interview by asking interviewees questions that were broad in scope, and as each interview progressed the questions would become more targeted. However, as the goal of phenomenological interviewing is to document the experience from the point of view of the subject, all

FIGURE 2
PHENOMENOLOGICAL INTERVIEWING PROCESS



interviewees were allowed and encouraged to provide detailed embellishments that would provide for a more robust interpretation of the interview outcome. Questions began with a focus on the interviewees' overall opinion of their company's current inventory management system and progressed to the subjects' viewpoints on how current practices positively and/or negatively impacted their jobs. Interviewees were provided a brief summary on blockchain technology and then asked to provide their thoughts on the benefits of utilizing the technology in their retail store operations. Interview notes were organized into subjects based on commonalities of themes that emerged from the discussions.

LEARNING OUTCOMES

How Is Blockchain and RFID Beneficial Within Retail Inventory Management?

Respondents indicated that the primary function of blockchain would be to provide employees instantaneous communication pertaining to the location and amount of a specific product. This is an overarching issue among all retail stores, suppliers, and distributors; lack of visibility and communication causes distrust and frustration between suppliers, carriers, and receiving departments. All interviewees felt that data exchange and visibility between IT systems was lacking to the point that jobs were impaired. With the implementation of blockchain, third-party programs can be integrated with blockchain (Sandoval, 2018). When systems are communicating, several steps of transferring information into additional programs are eliminated. The newly developed information network would constantly be expanding with more knowledge about products. With these improved capabilities, blockchain provides communication unlike ever before, opening a new world of possibilities. Figure 3 identifies the points when having inventory visibility is highly critical within a retail operational process. The dashed lines indicate a point where blockchain would be beneficial. The heavy arrows

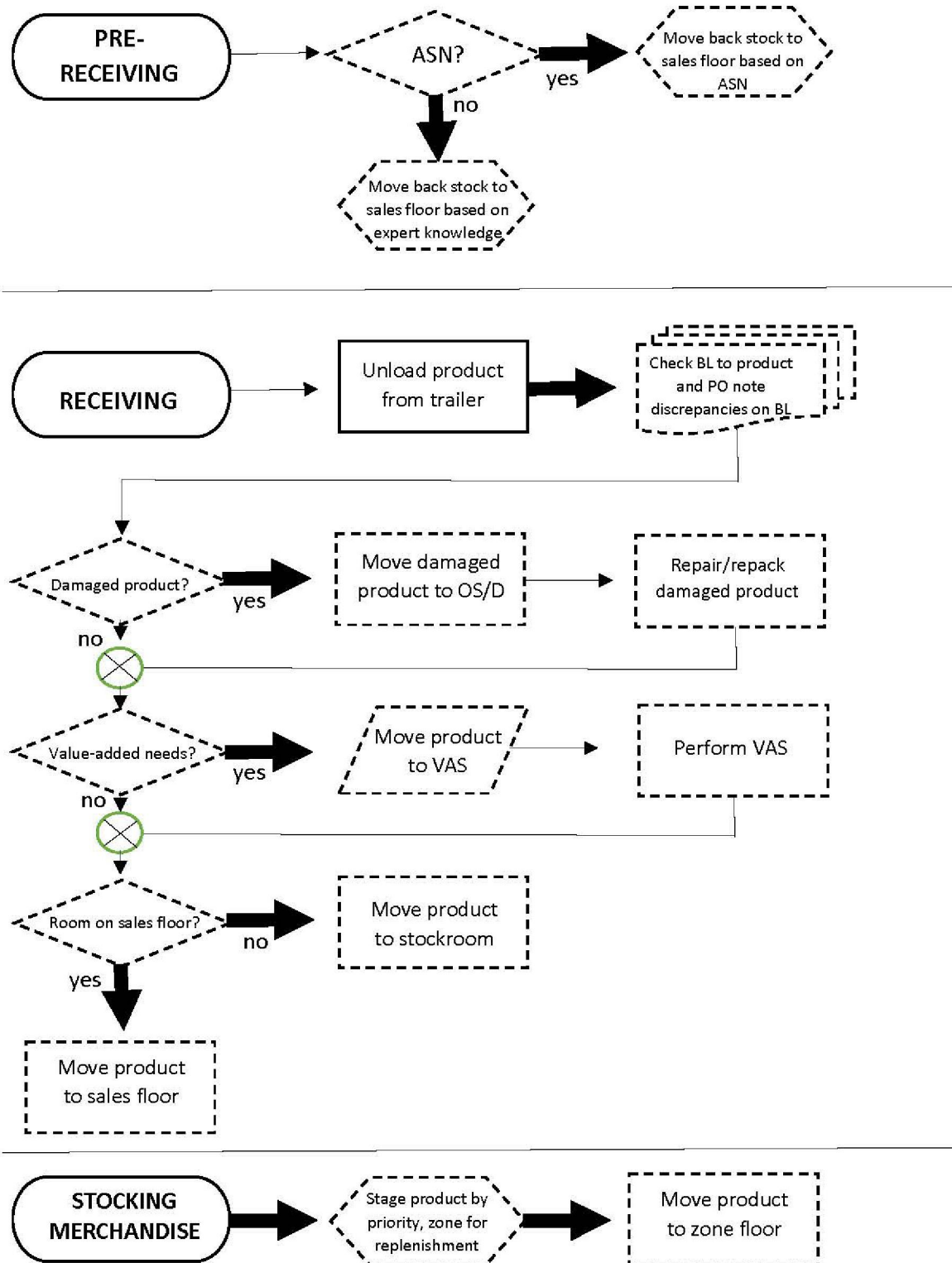
indicate product movement and where RFID tag technology would be beneficial. While each has merits, the technologies are different and promise to yield integrated benefits (Rometty, 2016).

Shipment reports are printed each week to give an estimated number of units to be delivered and an approximate processing time to help anticipate the number of labor hours needed to receive and process an inbound shipment. Some companies provide ASNs to verify that a shipment has been loaded and has physically departed the origin. Blockchain would allow all parties in need of the ASN to have immediate access to it. The ASN would not have to "be transmitted" through a data transaction to each individual in need. Blockchain would allow for the receiving manager to know the product was physically in route. Moreover, the stockroom and sales personnel would know that the product was in route and could have a qualified estimated time that the product would be available for customer purchase. This information would help employees to identify the critical products and to prioritize their work around the inbound product.

When a shipment is received at the retail store each case is scanned and each item in that case is also scanned to identify which items are to be placed on the sales floor immediately and what needs to be stored in the stock room. RFID tag technology would eliminate the need to scan products, whereas, when products are unloaded from the trailer they pass through RFID readers and are automatically updated into inventory. Again, while RFID tags provide efficiencies and accuracies during physical unloading and receiving, blockchain would allow all stakeholders the necessary documentation instantaneously. For example, a carrier may need to schedule dropping a trailer and picking up an empty trailer from the retail store. The carrier could be informed through blockchain technology that the trailer is over 50% unloaded (due to RFID tag indication), and the carrier could dispatch a driver ahead of time. In the same spirit, a customer that

FIGURE 3
RFID AND BLOCKCHAIN INTEGRATION WITHIN
RECEIVING AND STOCK MOVEMENT

(Dashed indicates blockchain potential and heavy weight arrows indicates RFID potential)



has an app providing inventory availability of a product would know if the product is available for purchase even though it is not yet positioned on the retail shelf. An online order fulfillment clerk would also know how many units of a particular SKU were received and could intercept the units in the stock room to prepare for parcel carrier pick up. This would reduce the need for the clerk to go to the retail floor to obtain the product only to have the product replenished from the receiving dock. Processes would be made more efficient.

During the shipment process, if a case of products is damaged the shipment carrier will refund or replace the case. This covers their liability of the items being damaged, however, in the process of doing so items are often lost or misplaced. When this happens, the retail store is unaware that they are missing it, if their system calls for the item later on, they simply assume that it is not in their inventory.

The interviewees agreed that blockchain would offer substantial solutions for shipment, as visibility increases between the distribution center, carrier, and retail store. All parties involved would know when and where the shipment items are and the exact contents of each case. If a carrier is required to re-package a shipment case the change would be made visible through blockchain, allowing the retail store to pinpoint where and which items are missing. They would also have insight as to the exact items that were shipped instead of only the number of items in each case.

Yearly the focal clothing retailers within the study, have inventory procedures where each item in the store and stock room is scanned and accounted for. After annual inventory, the inventory management system remains accurate for a couple of months. With the interaction between the product and delivery personnel, stock room associates, sales floor clerks, and consumers, the reconciliation is challenging between the physical and digital inventory count. With the addition of RFID tags and blockchain technology, one manager believes that inventory accuracy would improve to the extent that

store personnel would know the location of each product item, even if it was out of place, and be able to retrieve an item for a customer so that a retail sale would not be lost due to a lost item within the store. In this scenario, RFID and blockchain technology would actually help to increase sales transaction through inventory visibility.

With the new technology, time spent searching for items in the stock room could be minimized. If an item's location in the stock room is updated when shipment is processed, stock associates will waste less time locating items that are called for at the end of the night. This can be done through a combination of blockchain and compatible RFID-type chips implanted in all the clothing. Specific items can then be tracked and traced throughout the supply chain and once they hit retail stores, this would be similar to the technology used during Shanghai Fashion Week on the designer's fashion pieces mentioned earlier.

Retail stores across this particular clothing retailer are unable to see what items they will be receiving ahead of time. If they were aware of what items were coming store managers could compare the items to their best-selling departments and the current local trends to decide which items the store will need more or less of. Once the comparison is made managers can inform the upper management of their insight to possible trends which can help forecast future inventory needs more accurately.

One area of frustration expressed by a store manager was the lack of visibility on the retail side. While the upper management has access to detailed data about each retail store's profitability, sales, and trends, this information is not communicated well to individual retail locations. Blockchain would allow for that barrier to be broken and open up better communication between the corporate office and their stores by providing real-time updates accessible by both parties. It is not that the retailer is unaware of the trends, it is the manual approach that is prone to human error and miscommunication

between key stakeholders that causes inventory inaccuracies. Blockchain is a perfect automation solution that would get rid of these asymmetries between the corporate office and individual retail stores.

Additionally, there is an issue of visibility between retail stores. Often, customers will inquire about the availability of an item at another location; currently there is no visibility between retail locations about current inventory. Blockchain would minimize it, if not eliminate it, by allowing retail stores to search for items at another location for a customer. This is and would also be the case for visibility about what the distribution center has in stock. Currently, employees are only able to search the store website for items which pulls from a different distribution center than where store stock is shipped from. Having this level of information would improve the quality of customer service by letting them know

that while an item may be out of stock online and in-store it will be arriving at the store within x-amount of days. All benefits of blockchain technology within the retail inventory management are summarized in Table 1.

What Are Some of the Pitfalls of Blockchain and RFID in this Arena?

On a retail level there are lots of part-time employees and a small team of managers. With this comes lots of young adults and teenagers starting out at their first job, the learning curve is long, and the amount of human error may be substantial. A store manager said the following:

“If it wasn’t for human error the current system would work just fine.” - Kylie, Store Manager

Blockchain can improve the way that humans communicate with one another and share

**TABLE 1
SUMMARY OF BLOCKCHAIN TECHNOLOGY BENEFITS**

Benefit	Main Issue	Blockchain Solution
<i>Visibility</i>	Corporate office and distribution center does not share information about trends with retail store	Information about store-specific trends would be made available on blockchain and shipments would reflect statistics
<i>Accuracy</i>	Receiving shipment of unwanted items	Needed and already available items would be accurately accounted for through a form of blockchain-compatible RFID tagging. Information would be made available to all parties involved
<i>Time</i>	Non-value-added time spent looking for non-needed or unavailable items	Similar to accuracy, all available items would be properly calculated improving replenishment processes
<i>Communication</i>	Carrier, corporate office, retail store, and distribution center systems don’t have a secure platform to integrate and communicate on	Through blockchain, all systems would have a secured platform to communicate information about inventory

information, but it cannot force an employee to upload a document right away, check their calculations, or go the extra mile to take out a ladder and pull the requested shirts from the top shelf. On the positive side, however, an integrated use of blockchain and RFID technology can allow for a more automated account of stock movement from trailer to stock room to OS/D and to the retail sales floor. In fact, once on the sales floor, an item equipped with an RFID tag can be more easily located since the nearest tag reader will identify the item as out of place. In this manner, the technology can help to reconcile inventory discrepancies from improper stock movement by retail personnel or by customers moving product within the store.

Currently there is not a priority put on damaged items whether they come in from shipment, are found on the sales floor, or are returned as damaged. This is so because they are considered low-priority due to the extra time they take to process and their minimal effect on day-to-day sales. While it does not seem as though damaged items influence sales, there is an effect on stock. For example, if an item comes out of the shipment case damaged it is still processed, then hopefully “damaged out” (i.e., written off) within the next month; and “until it is “damaged out” it throws off inventory which can then have a domino effect on replenishment. This is a type of pitfall that blockchain could catch a bit earlier, but it still remains up to the retail store associates to properly record it on blockchain ledger as damaged.

One of the major concerns of blockchain implementation is the cost. Each company would have to perform extensive cost-benefit research to determine whether the short-term costs would outweigh the long-term cost savings. During the interview process, two key concerns surfaced about cost; that of employee training and long-term manufacturing costs.

“It [blockchain] could be helpful, but on a retail level it is so many peoples’ first job so there is a ton of human error.

Introducing new technology would be difficult and the [knowledge] requirements for employees could go up.” -Kate, Full-Time Stock Associate

If blockchain were to be used on a retail store level, all employees would require additional training to master its functions and procedures. Additional training would mean spending more money on employee compensation that does not increase sales. To counteract high employee turnover ratios companies would most likely increase the employee education or work experience requirements which would still cost the company money in increased wages.

One of the great benefits of blockchain is increased visibility throughout the supply chain, making it easier than ever for customers to trace the origin of the products they buy. This would be good from an ethical perspective for those companies that unknowingly may be associated with a supplier utilizing inhumane working practices. However, this may cause a shift for companies away from outsourcing their manufacturing to overseas suppliers that are less expensive.

“Most fashion retailers would like increased customer visibility, but when it comes down to it, it’s all about the money. The retail market is the first to take a hit when the economy is not doing well, if companies start outsourcing less it might hurt them in the end financially.” – Ryan, Store Manager

Many clothing retailers depend on outsourcing their manufacturing internationally in order to keep their prices affordable and maintain their customer base. When the economy declines consumers put off buying new clothes or search for cheaper substitute clothing outlets, such as, at thrift stores. Clothing stores have tried to offset this financially by sourcing manufacturing overseas.

IMPLICATIONS FOR MANAGEMENT

With new technologies constantly arising, it is imperative to stay up to date with what could be the next step. The implications of blockchain go much deeper and beyond the limits of this research, and lockchain can be applicable to a vast variety of fields and industries. Medical companies and hospital executives are already researching blockchain with plans to implement within the next 5 years according to an article from Forbes (Marr, 2017). They state:

“...to create a common database of health information that doctors and providers could access... higher security and privacy, less admin time for doctors so there’s more time to spend on patient care, and even better sharing of research results to facilitate new drug and treatment therapies for disease.”

The benefits of blockchain on a base level are the same across all industries, increased visibility between practitioners, reduced non-value-added time, and broader accessibility while improving privacy. The biggest advantage within the medical field is the possibility for data management. The medical field is constantly conducting research on new therapies, medicines, and alternative treatments resulting in massive amounts of data left unorganized, unshared, or forgotten about. By using a blockchain platform all that data can be shared and verified within seconds. As mentioned earlier, the use of private and public blockchains will need to be developed more to allow for sensitive information, such as patient history, to be securely shared between medical practitioners.

More recently, there have been companies conducting extensive research on how blockchain and RFID technology could impact their industry. Walmart Inc. is among some of the first to put blockchain to use in their business operations; they are now requiring their vegetable suppliers to use

blockchain (Loten, 2018). The main reason Walmart chose this change was due to E. Coli outbreaks from recalled lettuce earlier this year. What they found was that customers avoided all lettuce products completely no matter the store or location, impacting their sales. By using blockchain they are now able to pinpoint the source of the E. Coli infestation and exactly which vegetables at which stores need to be recalled. This advancement protects their customers and their sales. For some more notable business applications, please refer to Table 2.

Our contributions illustrate the “extended potential” of blockchain integrated with individual operations; linking blockchain to an inventory management system of a retailer. What would be the benefit? There is an escalating need for retailers to fulfill online consumer orders from existing store inventory and shipping to customers from a store using a parcel carrier or even a local transport courier-type service, allowing pickup at multiple store stores, distributing direct from DC to consumer, or even the old fashioned back order from DC to store to rain check walk-in consumer at store. This has broadly been labeled omnichannel distribution. Retailers are truly searching for new strategies to manage the efficient fulfillment of such orders. Blockchain linked with operational inventory and stock movement systems, and enhanced with RFID-type technologies, could provide information visibility to the critical people in the supply chain so as to make the various processes and inventory visible where, when and to whom it counts most at this stage.

This suggests connecting consumers to the Blockchain, where access is granted in the Blockchain where they need critical information in order to most efficiently obtain their product. Consumers’ confidence in products and orders being available to them when they want is very important. Without such consumer confidence, consumers will search for the product location from competitive sources. From this perspective, blockchain technology may have an extended benefit that reaches into the retail consumer domain.

TABLE 2
NOTABLE BUSINESS APPLICATIONS OF BLOCKCHAIN TECHNOLOGY

Initial research	Current/Intended Use
2017	Offering building of customized blockchain to customers. For example, ‘Food Trust’ to track and trace origins of produce
2017	Requiring all vegetable suppliers to use blockchain
2017	Currently offers a blockchain prototype to their customers for shipping operations
2014	Developed ‘Dragonchain’ for internal use and as of 2017 it is now available to the public as a way for companies to join blockchain
2018	Researching “new ways to share information”

The application of the Internet of Things (IoT) to blockchain suggests that it could help companies track, trace, and manage activities and processes with more precision attention to the value achieved within their supply chains (Rejeb, Keogh and Treiblmaier, 2019). While optimizing product management through warehousing and transportation by leveraging the IoT, combining IoT with Blockchain increases advantage and scope through enhancement of B2B management and accountability when it comes to materials and product flows. Rejeb, Keogh and Treiblmaier (2019) suggest that combining Blockchain technology to the IoT can enhance efficiencies and effectiveness of supply chains. Included in the IoT is RFID technology. They leave for discovery, however, the potential to move beyond the myopic focus on B2B and leverage the capabilities of the Blockchain technology within the walls of retailers and between the walls of retailers and DC’s and consumers by connecting the IoT RFID technology to Blockchain technology.

The IoT connected with blockchain technology can assist, for example, a transport driver in signaling when the temperature of a shipment is out of tolerance and the driver can take immediate steps to rectify the situation (Shrouf et. al, 2014). Hoffman and Rüsç (Hofman and Rüsç, 2017) propose that RFID and Blockchain can work in tandem to integrate information exchange within the manufacturing process to alert the need for materials replenishment at the specific production line point. Similarly, connecting IoT to Blockchain through RFID can assist retailers and customers when a product location or stocking level is “out of tolerance” and the retailer can take measures to replenish while a customer can know the status of inventory to fulfill their immediate need whether stock is at the retailer, in transit to the customer’s home or available at a secondary retailer location. Specific information would be made accessible by approved consumers (as approved private BC network members) as permitted and each consumer can identify the location of products and check the progress of an ordered item (Bashir 2017; Kim and Laskowski 2016). In this way, the combination of

RFID and BC can enhance the timeliness and accuracy of information exchange and provide consumers with the availability of the items of need (Chen et. al 2014; Cui 2018; Yan-e 2011). The IoT information via RFID can reside in the cloud and be distributed to consumers, as a need arises for a retail item. A consumer network member/ subscriber can access the specific information via an application through a smart phone, for example. The machine-to-machine and machine-to-human interactions provide a consistent and seamless flow of credible specific information that is most useful for consumer purchase decisions and retail product inventory positioning (Saragih et. al 2018).

The word “credible” being the operative word here in the reference above. The distributed ledger behind any blockchain makes a record of any and all retail purchases, returns, item movements across RFID enabled technologies, loading and unloading of inventory, and essentially all transactions taking place between the point of manufacture and point of sale. The distributed ledger records are immutable and, therefore, impossible for retailers or retail associates to edit any inventory transactions manually. Inventory miscounts, wrong charges, losses, and damages are all traceable via blockchain ledger. Consequently, credibility of inventory keeping rises, creating efficiencies from which both the retailer and the consumer benefit. Rejeb, Keogh and Treiblmaier (2019) propose key areas to leverage the interaction of the IoT and blockchain. Within inventory management and warehouse operations, such interactions have the capability to provide real time inventory visibility, avoidance of stockouts, agility and quick response to process and inventory inadequacies associated with, for example, lost items within a facility. It is our position that such competencies of leveraging the IoT, such as with RFID technology, and with blockchain technology, could also be applied within the retail setting. Doing so, would potentially provide retail to consumer gains similar to the service efficiencies and effectiveness that are achieved within the DC.

CONCLUDING REMARKS

The purpose of this research was to explore the potential benefits blockchain technology could have on current inventory management practices within retail. The interviews conducted revealed some core issues at the retail store level such as inability to find a clothing item, replenishment issues, shipment, time, visibility, and human error. Blockchain could have a major impact on the visibility between corporate, distribution centers, shipping companies, and the retail store by providing real-time updates on productivity and shipments. Time can be used more effectively towards customer service if associates are able to locate replenishment and make shipments quicker than current processes allow for. With increased accuracy of current inventory, “can’t find” replenishment items would be better customized to the stores’ exact needs.

While blockchain could be very beneficial in most areas of inventory management, there are still concerns to overcome. The main concern from a business and economic standpoint is the cost of implementation and if costs outweigh the potential benefits in the long or short run. One of these costs would be the additional training required for associates; a possible solution to that cost, at least temporarily, would be for only managerial level employees and above to receive training due to high turnover rates among part-time associates. However, when RFID and blockchain technology work in tandem the benefits far outweigh the costs.

While some companies mentioned like IBM and Walmart are already researching and implementing blockchain usage, it is likely that smaller companies will have to take smaller technological steps to get there. Research on blockchain is a part of those smaller steps towards improved supply chain and inventory management practices.

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