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Modernizing the Supply Chain of Airbus by Integrating RFID and Blockchain Processes

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Introduction

Radio frequency identification, or RFID, is one of the areas within the aviation industry that is gaining momentum for improving efficiencies across various operational functions. RFID technology is not new within other industries that tend to be more responsive as early adopters to the technology than the aviation industry. More airlines/airports and aircraft manufacturers are adopting this technology as a key strategic advantage in the future. Currently, many of the full-scale implementation organizations from late adopters have strategically integrated RFID technology into the manufacturing supply chain to tag parts and for airports/airlines to track baggage and passengers throughout their airport journey. Literature remains rather sparse in the implementation and success factors within the aviation supply chain as a number of businesses have kept much of the details discreet to differentiate themselves from their competitors.

In this paper, we will examine the state of the early adopters in aviation to implement RFID technology into their supply chain for tracking parts, identifying information, logistics media, and other process improvements in component maintenance management. Airbus, which was the first company in the aviation industry to adopt RFID, will be examined in detail ("Airbus Extends", 2012). The review includes the growing numbers of airports (and airlines) use of RFID to track baggage and passengers. Using information from published secondary data, the researchers review the early adopters of RFID in aircraft manufacturing who are employing RFID to improve the supply chain. The authors review how the use of airports and airlines has transcended to passenger tracking to improve airport operational efficiency and increase passenger satisfaction. By identifying key trends in the aviation supply chain (e.g. *blockchain*) and the value-added processes in manufacturing and passenger experiences, this paper heightens the awareness of areas in need of further empirical research in order to understand the key success factors with RFID implementation in aviation.

A Historical Perspective on the Use of RFID in the Airline Industry

Historically, the airline industry has been slow to upgrade technology in general, even as airlines have lost more bags. McCarran International Airport in Las Vegas Nevada and Hong Kong International Airport were the only airports with large-scale tagging programs as far back as 2006 (West, 2006). Delta Air Lines announced that it was investing $50 million to deploy Radio Frequency Identification (RFID) baggage tracking technology at 344 stations around the world while claiming to be the first U.S. carrier to provide real-time tracking of luggage for customers (Morrow, 2016). According to SITA, a Switzerland-based technology provider that tracks baggage information for airlines, use of the technology resulted in instances of airlines mishandling baggage reaching an all-time low in 2017 or a 70% reduction over the past 10 years (Magnusson, 2017). This resulted in billions of dollars saved in the airline industry in spite of the steady growth of passengers worldwide.

Airbus, a consortium of several European aerospace companies, started testing RFID in the 1990s, but like many corporate giants, the company did not have a coordinated plan. In 2006, Airbus made a conscious decision to implement the technology and launched an initiative in 2007 to improve overall efficiencies in the entire life cycle across its product portfolio using RFID (Attaran, 2012). Airbus stated, "This innovation, which will bring value-chain visibility, error-proof identification and efficiency savings in component lifecycle management, will be progressively rolled-out in 2013 to all seats and life vests for the A320, A330 and A380 aircraft families" ("Airbus Extends," 2012). Airbus has incorporated the use of RFID tags on its new flagship airliner, the A350 XWB, to provide an efficient automatic process to record, collect, and manage component information. Photo 1.0 shows the RFID reader scanning a life vest package.

Photo 1.0 shows the RFID reader scanning a life vest package.

Source: © AIRBUS S.A.S. 2016 – photo by P.PIGEYRE / mater films.
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Photo 2.0 shows the A350 XWB, which includes all maintainable parts with RFID tags. Airbus has identified RFID technology as the key intelligent enabler to improve the value chain processes within its Smart Factory to help ensure quality and cost reduction (Denkers, 2014). The term “Smart” factory relates to the integrated tools designed to communicate information across the manufacturing process in an effort to better support the process improvement to mitigate errors, reduce cost, and increase output. The Smart Factory or hybrid factory consists of robotic tools controlled by people in the assembly process as compared to the fully automated robotic assembly found in automobile production. By using the Internet of Things (IoT) platform that connects both people and integrated tools, Airbus is able to speed up its manufacturing process (Marcus, 2016). The auto industry has historically used robots in their precision manufacturing process.

Photo 2.0 shows the A350 XWB-1000 taken at the 2018 Singapore Airshow.

Source: © Photo by Michael D. Santonino III/ photographer.

BMW automobile manufacturing factory floor design consists of all glass window, wood flooring and no electrical outlets. All power used in the operation is through electrical induction to power the workstation with robotic assist tools on the factory floor. The IoT platform allows Airbus workers in the manufacturing process to do such things as drive thousands upon thousands of bolts. Information scanned and captured about an airplane’s metal skin help to determine what size bolt is needed in a given hole, and the torque required for installation. Hence, information can be spontaneously sent to a robotic tool, which completes the task (Marcus, 2016). Robots paint, weld, seal, and inspect aircraft at a speed, and consistent accuracy level that humans cannot match (Richter & Walther, 2017).

State of the Value Chain for Airbus - Tracking Baggage and Passengers

In the retail space, Walmart influenced its suppliers over the years due to the sheer volume potential for a Walmart supplier in the value chain. The bargaining power of Walmart's suppliers are relatively low, as Walmart's "Everyday Low Prices" must translate to low supplier pricing. For the aerospace industry, the management of suppliers remains a major challenge due to the long supply chain and the deep dependence on the outsourcing components (Gordon, 2006). Due to fierce competition with the two giant aircraft makers, Airbus and Boeing, the manufacturers' attempt to build supply chains with timely delivery of defect-free products and compete for better deals by selecting components for their newly designed aircraft, incurred conflicts due to their rivalry (Shawei, Hipel, & Kilgour, 2014). The increase in demand for large aircraft are putting pressure on suppliers in the supply chain to invest, innovate, and share in the development risk to sustain a viable partnership with the manufacturers (Hollinger, 2016). This results in an overdue modernization of supply chain in the aerospace sector. See Image Table 1 showing the aircraft demand for the top three regions in the world.

Image Table 1: Aircraft demand over the next 20 years.

Region: Asia-Pacific
Demand Forecast: 15130 units

Region: North America
Demand Forecast: 8330 units

Region: Europe
Demand Forecast: 7570 units

Source: © Photos by Michael D. Santonino III/ photographer; 78% of the demand shown in Table 1 for top three regions. Other demand found in the Middle East, Latin America, Africa, and former Soviet Union member states. Total demand 47,000 aircraft. Hollinger (2016).

RFID has a role in the digitalization of the value chain for Boeing, Airbus, and the downstream suppliers. For example, Airbus has widened its range of RFID tag suppliers by selecting Brady and Fujitsu to supply the RFID Integrated

Nameplates to enhance internal traceable parts, in a follow-up move from the earlier strategy for maintainable parts on their A350 XWB aircraft in 2010. The plan included application of RFID tags to seats and life vests across the Airbus fleet in 2012 ("Airbus Introduces," 2014). According to Airbus, RFID tags contribute to value-chain visibility, error-proof identification and efficiency savings in the lifecycle and configuration management of traceable components. Airbus ensures that all parts are properly tagged using a system called Airbus Tag Control (ATC). Photo 1 shows the tagged life vest package that will allow tracking and maintenance process improve in the product life cycle (Swedberg, 2017).

Airport/Airlines Tracking of Baggage and Passengers

Marketing research data shows that passengers prefer technology-delivered over people-delivered service when flying domestically and internationally. For example, passengers who check their bags at participating airports can receive RFID (radio frequency identification) paper tags which store data that can be captured by scanners using radio waves, giving travelers the opportunity to personally track their bags on Delta's or other airlines' apps (Silva, 2016). Martin (2016) found that RFID tags can reduce the rates of lost luggage by 25% and have already reduced lost luggage rates by 60% over the past seven years.

As vast amounts of data are quietly "tracked and analyzed" in the social media industry to target potential customers with advertisement campaigns so will passengers who opt-in get "tracked and analyzed" at Finland's largest airport. Helsinki Airport was the first in the world to track passengers' movements in real-time with a WiFi enabled infrastructure capable of monitoring the movement of passengers' via smartphones – from the car park to the departure gate (Kitching, 2014). Opting in with the use of WiFi or RFID at airports are some of the new trends in airport management.

Other trends include augmented reality applications (apps) used with a Global Propositioning Satellite (GPS) and smartphones at the Copenhagen Airport to guide passengers around the airport using their mobile devices. RFID and WiFi technology enablers are increasing at airports as access points used to determine the location of each traveler's mobile phone are seeing more use (Welling, 2011). It will be imperative for the aviation industry to understand the customers' perspective and the value it provides customers as more airports and airlines are poised to collect data for operations efficiency and passenger communications with RFID and other tracking technologies.

Photo 3 shows the mounted RFID readers with baggage handlers. Lisbon International Airport in Portugal was the first European airport to install an RFID baggage system at the end of 2008. It was followed by Milan's

Malpensa Airport in Italy as the second airport in Europe, and the third worldwide, to implement comprehensive RFID baggage tracking across the entire baggage handling system from baggage check-in onwards (Wessel, 2009).

Photo 3.0 shows the mounted RFID readers with baggage handlers.

Source: © Photo by Michael D. Santonino III / photographer. Red arrow points to the location of the mounted RFID reader. Read rate and belt speed vary by airport system configurations.

Early adopters of an RFID baggage system were McCarran International Airport and Hong Kong International Airport. Both airports began with the implementation of large-scale tagging programs in 2006 (West, 2006). Photo 4 shows McCarran Airport entrance sign.

Photo 4.0 The McCarran Airport entrance sign.

Source: © Photo by Michael D. Santonino III / photographer

Among the digital technology schemes, RFID remains one of the most widely used technologies airports are interested in implementing. Many pilot tests completed were located at numerous European, Asian and U.S. airports. For example, Heathrow Airport in London spent 150,000£ for an RFID baggage tracking system test lasting six months in an effort to compare the number of misread bags between RFID and bar code systems (Kamath, 2008). Hong Kong Airport is now using RFID tags for 100% of the 40,000 bags that leave the airport every day. The implementation results show the overall read-rate accuracy of the airport's baggage - handling system has increased from an average of 80% for bar-code-only tags to 97% for the integrated RFID tags (Silk, 2016). IATA forecasts that RFID deployed in 722 airports over a six-year period between 2016 and 2012, which, represents 95% of passenger numbers globally (International Air Transport Association, 2016).

Airbus' Value Chain Visibility (VCV)

In 2010, Airbus selected CSC to develop and support Airbus' Value Chain Visibility (VCV), which includes the Auto-ID and RFID technology programs (Grandis, & Brady, 2010). Mr. Carlo Nizam who has since moved on to the CIO position in India, previously led the VCV programs (C. Nizam, personal communication, May 18, 2018). The program utilizes passive and active RFID tags to capture information to improve operational efficiencies. "Benefits '*connecting to things*' provides better productivity, better cycle time, and better quality" and "by knowing what is where and when, you can now start to visualize things...a real-time view of your operations" (Nizam, 2015, 15:47). A recent study by Reyes et al (2016) revealed that one of the determinants of RFID adoption implementation stage, were influenced by internal and external drivers, management leadership style, barriers, and benefits.

The main goal of both internal and external RFID implementation drivers comprised of improving a multitude of organizational and supply chain process outcomes. Internal driver reasons for adopting RFID were noted as increased visibility of inventory and supply chain, increased labor efficiency, and improved stockout reduction and asset tracking. At the same time, all of the internal and external drivers for implementing RFID systems are regarded as benefits from a cost savings point perspective (Vijayaraman & Osy, 2006). External drivers were identified by a survey performed in a study by Li et al (2010), which detected compliance and customer pressures, standardization of technology and maturity leading to cost minimization.

Successful implementation of RFID processes is dependent upon the go-no- go decisions of top management and in the case of a funded decision, middle management follow-through. Barriers that must be mitigated for successfully implementing RFID technology include, lack of a long-term benefit vision and understanding in general, cost constraints, issues regarding technology, and concerns about privacy security. Bhattacharya (2012, 2015) noted several barriers to RFID adoption which included concerns facing issues with privacy, high costs of RFID implementation, issues with RFID readability, data warehouse integration, and the lack of standards.

A research study by Reyes and Frazier (2007) showed benefits of improved accuracy and availability of information, increased process automation, improved customer service, and enhanced operations capabilities from RFID implementation. Reyes and Frazier (2007) cited other benefits, which included; increased sales as a result of stockout reductions, increased safety and security, better supply chain planning and collaboration, automatic inventory replenishment, and real time tracking.

Value Chain Inputs

Taking into account the RFID early adoption model to successfully adopt and implement RFID to realize process transformation, several key value chain inputs must be corrected, improved, and optimized. Figure 1.0 shows the RFID Early Adoption Process Model. For example, a recent article of Financial Times (Tieman, 2016) identified several key issues that created hurdles in the value chain inputs, thus growing concerns about forward thinking of management leadership and organizational culture. One hurdle was the delayed deliveries of the new engine option for the Airbus A320neo (new engine option).

This bottleneck in the supply chain created a stockpile of aircraft valued at more than two billion dollars. Assembly delays are nothing new to the aircraft manufacturing industry, although the need to create a manufacturing industry with automation, robotics, and standardization, were identified (Tieman, 2016). According to Tieman, many new entrants into the aircraft manufacturing domain such as Bombardier of Canada, Embraer of Brazil, Irkut in Russia, and Comac of China, rely upon common suppliers to fulfill supply and satisfy customer demand. Some are even manufacturing their own aircraft parts. All of these factors

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contribute to the value chain inputs by embracing forward thinking, minimizing risks while maximizing benefits, are process improvement driven, create excellence in harvesting technical knowledge and skills, and prove that they are capable and able to overcome issues affecting completion of production on time without compromising quality.

As of the time this article was written the problems with the Pratt & Whitney powered A320neo engines had yet to be resolved. The European Aviation Safety Agency's issuance of an emergency airworthiness directive resulted in the grounding of several aircraft (113 in total) and 18 customers of Airbus (Charlise, 2018). Charlise (2018) stated the problem with the PW1100G-JM engine powering the A320neo is related to the knife-edge in the aft hub high pressure compressor. Hepher (2018) reported that due to the engine problems, Airbus has stopped delivering A320neo aircraft powered by the Pratt & Whitney engines. This setback and uncertainty of resolution timeframes are indicative of relatively high scenarios of supply chain disruptions and negative financial implications, as potential revenue is placed on hold indefinitely.

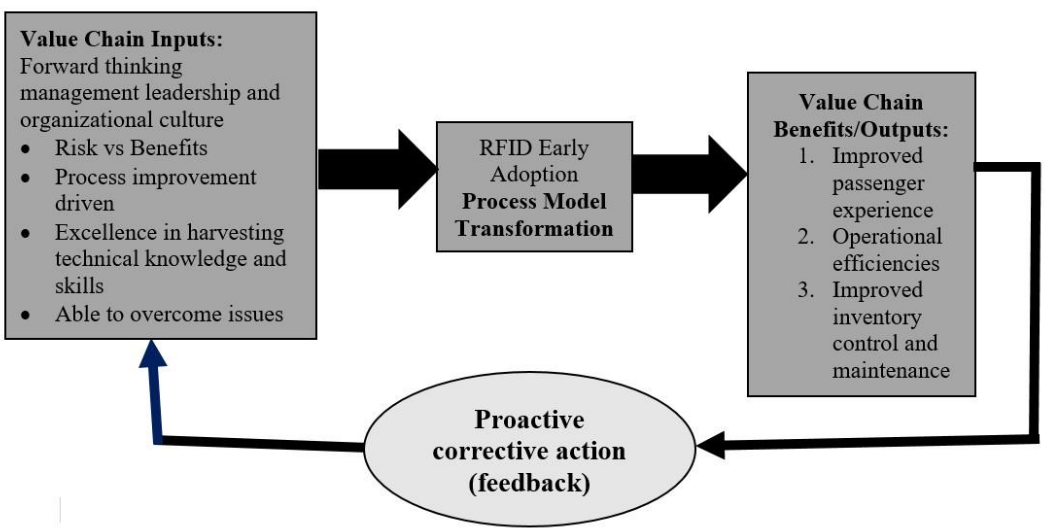

Figure 1. RFID Early Adoption Process Model

Value Chain Outputs

The use of technological advances and innovation of data science has incorporated the utilization of blockchain technology to analyze and optimize the processes that use RFID technology. For example, the value chain benefits (outputs) to minimize queue times and improve operational efficiencies. Faster processing speeds and lower costs are factors to consider when optimizing operational efficiencies. Fastest time and lower costs are factors to consider when optimizing operational efficiencies. Blockchain is a framework which consists of a set of private distributed ledgers and a single public ledger arranged in blocks. Each private ledger allows the private sharing of custody events among the trading

> partners in a given shipment. Privacy is necessary, for example, when trading high-end products or chemical and pharmaceutical products. The second type of ledger is a type of blockchain public ledger. It consists of the hash code of each private event in addition to monitoring events. The latter provide an independently validated immutable record of the pseudo real-time geolocation status of the shipment from a large number of sources using commuters-sourcing (Wu et al., 2017).

Airbus is looking to use blockchains to monitor the many complex parts that come together to make an airliner (Hacket, 2017). According to Hatchinson-Kent (2018), Airbus envisions a successful synergy between RFID and blockchain technologies working together to maximize operational efficiencies, improved performance, faster deliveries, reduced errors and costs, yielding to a positive impact of supply chains in the future.

> Blockchain has been called 'the next generation of the internet', a powerful set of technologies forecasted to disrupt centuries-old systems of record-keeping. But what is it, how will it change the way we interact, and what does Airbus contribute to the new conversation in which the word on everyone's lips is 'trust'? (Holl, 2017, Overview)

According to Holl (2017), teams across the company have aligned to position Airbus as an early adopter. Data Driven Technologies VP, Ronny Fehling, sees the handover of physical to digital assets and vice versa as the single biggest weak point for blockchain. Fehling noted a similarity in the struggles RFID technology met, where frequent cases of interference and obstruction did not permit the technology from broader adoption (Holl, 2017). One of the main takeaways of the Airbus article is the building of long-term trust and collaboration among all of the stakeholders and partners using the blockchain technology. Sharing data must be implemented in a way that benefits every partner strategically in order to maximize operational efficiencies, which in the end, are passed onto the customers with emphasis in time sensitive interactions without any unnecessary delays.

Looking at the RFID Early Adoption Model, combining RFID and blockchain technologies, the goal is to work them together, as the process model transforms from early adoption stages to maturity levels. Ultimately, this would inevitably enhance the vendor/customer/passenger satisfaction experience, improve inventory control and maintenance, while at the same time allowing access to proactive corrective action/feedback. In turn, feedback is analyzed within the value chain inputs to initiate forward thinking management leadership and improve organizational culture among all stakeholders. This will outweigh potential risks and benefits, instill a culture of continuous process improvement with a results-based environment, and provide excellence in harvesting technical knowledge and skills, while at the same time hopefully overcome any issues that may arise as a result. In turn, the end-result would yield a predictable and stable process that is measureable, verifiable, and validatable.

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Conclusion

Our goal has been to identify key trends in the aviation supply chain by reviewing the modernization efforts at Airbus with RFID and Blockchain processes. By providing examples of early adopters with RFID and a framework will extend the literature that lacks in the implementation and success factors within the aviation supply chain. The aviation industry requires highly complex solutions to both the end user (passenger) and manufacturing segments of the industry. Baggage tracking across various airports, airlines, and even international borders often necessitates the development of new technologies, processes, and standards. First movers, such as Delta Airlines, have paved the way for continued improvements and greatly reduced incidences of lost baggage. As an example, from a customer service perspective, it has made the ability of a passenger to monitor their baggage during a trip a common practice and thereby improving the customer experience.

Technology solutions for airline manufacturers are even more sophisticated given the many components involved in designing, testing and building large aircraft. This includes different levels of suppliers, component manufacturers, and various contractors and assembly plants. Once an aircraft becomes operational, the operators (airline), maintainers (MRO), and regulators enter the equation, all with additional requirements and processes. As RFID, blockchain, and related technologies are more widely used and become essential tools within the global supply chain, information and process security has become crucial to ensure integrity throughout the system.

Another factor to consider is the increasingly complex documentation required, which may include a combination of electronic and paper (e.g. parts tags) formats that, in the end, must be compiled together to ensure proper aircraft certification. Fortunately, tools such as RFID and blockchain technologies have been integrated successfully and have helped increase confidence and simplicity throughout supply chain networks. All of these technologies and methods will continue to mature as new ones are developed and integrated to make the movement of baggage and manufacturing of aircraft more efficient and profitable.

Further Research of RFID-Blockchain in the Aviation Industry

All evidence indicates that RFID and Blockchain technologies will continue to play a significant role in all aspects of the airline industry. From passenger and baggage tracking to the increasingly complex airline manufacturing process, these and unknown technologies still to be developed, will help ensure both safety and growth within an industry that plays such an important role in today’s world economy. Further research by this team of authors will include a number of related topics. One obvious direction for future research study would be to investigate newer technologies and relate how they mature within various industry segments.

As we continue to increase our dependency on digital processes and data, information reliability and security become a paramount concern with significant time and monetary components at stake. Since there are very limited number of major aircraft manufacturers, another research approach would be to investigate the impact of manufacturers' standards on their suppliers. This would be especially true among global production networks where similar parts are produced in multiple manufacturing plants worldwide. According to Koursaris & Manley (2017), product homogeneity can determine whether the manufactured products bear the same physical characteristics and quality as similar products from other manufacturing plants within the organization or even other competing manufacturers external to the organization.

Given that vendors typically serve more than one manufacturer, a look at whether a single standard is feasible could shed light on the evolution of RFID and blockchain within the industry. There are indications that Airbus and Boeing, for example, understand this and are putting efficiency and practicality above competition (Roberti, 2004). Such measures will significantly improve the efficiency of these emerging systems and likely increase applications across the supply chain and aviation industry at-large.

Another direction for additional research would be to look deeper into both RFID and blockchain technologies for additional applications as well as potential barriers that would impact broader acceptance. Industry sectors such as general aviation and corporate aircraft manufacturers, engine and component manufacturers, as well as MRO organizations, should be investigated to determine potential applications.

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Appendix A

Terminology

Active (RFID) tag – a term to describe a physical tag that embeds an antenna and active electronic device inside the tag that allows information transmitted and received within a defined range.

Augmented Reality (AR) Applications – a term used to describe the technology that utilizes hardware and software in a combined form with live video imagery, Global Positioning Systems (GPS), cameras, high-resolution graphics, computers, and computer applications to provide real world experiences.

Block-chain – a term to describe an encryption technique used in digital currency in recent years and applied to other applications to provide levels of security and efficiencies in electronic operations and transactions.

Bottleneck – the term defines a delay in the supply chain process.

Commuters Sourcing – a term to describe the geolocation of the status of a shipment from a large number of sources.

Custody Events – a term to describe the legal owner of system data with the right to share information privately.

Electrical Induction – a term used to define an electromagnetic or magnetic inductions to produce energy (i.e. voltage, current) across a plane of an electrical conductor. Example are a metal plate (conductor) induced by an energy source (electromagnetic field).

External RFID drivers – a term to describe the positive effects of adopting RFID technology that are not under an organization's control.

Forward Thinking Management – a term to describe certain qualities that organizations must possess to excel, such as courage, emotional intelligence, strategic planning, execution oriented, and commitment. Also used to define innovative ways to solve problems.

Global Positioning Systems (GPS) – a term used to describe a satellite navigation system that determines the ground position (and speed) of an object.

Geolocation – a term used to identify or determine by some level of accuracy an objects geographic location (e.g. coordinates of Latitude and Longitude, street address, or other enhance markers).

Internet of Things (IoT) –a term coined by Kevin Ashton as cited in the RFID Journal (22 June 2009) to describe the network connecting objects in the physical world to the Internet.

Internal RFID drivers – a term to describe the positive effects of adopting RFID technology that are under an organization's control.

Passive (RFID) tag – a term to describe a physical tag that embeds an antenna inside the tag that allows an RF device (readers) to energize the electronic circuitry attached the antenna to encode or decode (store or read information) the tag's information memory. No battery source exists with a passive tag.

Pseudo Real-Time Geolocation Status – a term to describe the near instantaneous access time to real time information on geographic location. Delays due to weather, physical interference of objects, and system types are all function of the time delay.

RFID – an acronym for Radio Frequency Identification. RFID uses devices (known as tags) to capture electronically stored information from an energy source known as electromagnetic fields (or radio frequency waves).

RFID Reader – a term to describe a device, known as a radio frequency transmitter and receiver, used to gather electronic information from an active or passive RFID tag.

Stockout – a term to define inventory stock that is not available (or out of stock). Items can be backordered pending replenishing of stock items for inventory.

Value Chain – a term used to describe a set of activities, processes, or methodologies that add value to improve operational efficiencies, costs, and products or services by a company.
Scholars known for publications in this field: Michael Porter, Harvard Business School

Value Chain Visibility (VCV) – a term used to describe the ability to track parts, devices, components, or products in the supply chain process from the inception to the final destination.