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## OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

# A systematic literature review on the benefit-drivers of RFID implementation in supply chains and its impact on organizational competitive advantage

Janya Chanchaichujit<sup>1\*</sup>, Sreejith Balasubramanian<sup>2</sup> and Ng Si Min Charmaine<sup>3</sup>

**Abstract:** Application of Radio Frequency Identification (RFID) in managing supply chains has witnessed significant interest in recent years. However, the current understanding of the potential benefits that act as the motivating factors/drivers in implementing RFID technology (benefit-drivers), its link to competitive advantage, is fragmented and scattered across the literature. This formed the motivation of this study which seeks to address this gap in the literature through a systematic literature review. Based on a rigorous screening of the literature (2006–2018), the study develops a comprehensive understanding of the various 1) corporate-driven and 2) customer-driven benefit-drivers from RFID implementation. The “2 C” categorization of benefit-drivers is novel and should provide more impetus for practitioners to leverage from RFID implementation. Further, the link between the benefit-drivers and competitive advantage is understood and proposed in the form of a conceptual framework. Finally, avenues for future research are highlighted. The study findings and the framework provide a good starting point for academics and practitioners to further explore the opportunities in supply chain afforded by RFID

### ABOUT THE AUTHORS

Janya Chanchaichujit is an Assistant Professor in Logistics Management in the School of Management at Walailak University in Thailand. Dr. Chanchaichujit has over twenty years industrial, project consultancy and academic work experience. Her research interest focuses on incorporating various aspects of operational research applications, and technologies into the design and operation of sustainable supply chain management.

Sreejith Balasubramanian is a Senior Lecturer in Supply Chain Management, and Chair of the Research Committee at Middlesex University, Dubai. His areas of expertise include supply chain, operations management, and sustainability. He is also an expert data analyst with skills in statistical modeling and forecasting.

Ng Si Min Charmaine is graduated from School of Information System, Curtin University Australia. Her research focuses on operations and supply chain management.

### PUBLIC INTEREST STATEMENT

Application of Radio Frequency Identification (RFID) in managing supply chains has witnessed significant interest in recent years. However, the current understanding of the potential benefits that act as the motivating factors/drivers in implementing RFID technology (benefit-drivers), its link to competitive advantage, is fragmented and scattered across the literature. This formed the motivation of this study which seeks to address this gap in the literature through a systematic literature review. Based on a rigorous screening of the literature (2006–2018), the study develops a comprehensive understanding of the various 1) corporate-driven and 2) customer-driven benefit-drivers from RFID implementation. The “2C” categorization of benefit-drivers is novel and should provide more impetus for practitioners to leverage from RFID implementation. Further, the link between the benefit-drivers and competitive advantage are understood and proposed in the form of a conceptual framework.

implementation. A comprehensive review of this kind has not been previously undertaken and constitutes the novelty of this work.

**Subjects: Operations, Information & Technology**

**Keywords: Radio Frequency Identification (RFID); supply chain management; conceptual framework drivers; benefits; tracking; visibility; competitive advantage**

## 1. Introduction

Supply chain is no longer a cost center. Organizations have recognized the importance of having an efficient and effective supply chain as a means to building sustainable competitive advantage as it is the supply chains that are competing with each other in today's world (Medium, 2019; Sukati et al., 2012; Vijayaraman & Osyk, 2006). Customers have become more demanding, and more aware of the source of products and its quality, and hence want to have real-time visibility of their products along the supply chain (Gautam et al., 2017; Mejjaoui & Babiceanu, 2018). Supply chain traceability, the process of identifying and tracking the path of materials and products in the value chain (Kohli & Peng, 2017), has therefore become increasingly important in supply chain management (Fosso Wamba et al., 2016).

Among the different tools used to enhance supply chain traceability, Radio Frequency Identification (RFID) has witnessed significant interest in recent years, especially in sectors that require close monitoring of goods. RFID enables supply chain members to collect information regarding the products at every stage of the supply chain. It has seen diverse applications in variety of sectors/industries. For instance, in retailing sector, many large companies, such as Walmart, have set up RFID implementation mandates for their supply chain partners to enhance their visibility of thousands of products and suppliers (Fosso Wamba et al., 2016; Reyes et al., 2016). Similarly, RFID has witnessed significant adoption in the food sector (Li et al., 2017; Mejjaoui & Babiceanu, 2018; Mohammed & Wang, 2017). This is because, food supply chain networks have become more complex due to globalization, and RFID enables end to end supply chain traceability (from suppliers to end customer) of food items sourced from different countries (Piramuthu et al., 2013). Without RFID-enabled tracking, it becomes extremely difficult to swiftly locate the source of contamination of food products and to manage other quality issues such as freshness.

In addition to the retail and food sector, RFID has been also witnessed growing application in industries/sectors such as apparel and footwear (Majeed & Rupasinghe, 2017), manufacturing (Liukkonen, 2015; Tsao et al., 2017), automobile (Werthmann et al., 2017), asset management (Iluore et al., 2020), healthcare, pharmaceutical (Chanchaichujit et al., 2019b) and freight and transportation (Chow et al., 2007; Fu et al., 2015). RFID has also witnessed application in humanitarian food supply chains to monitor food security (Biswal et al., 2018).

We are now witnessing even wider acceptance RFID is supply chains because of the emergence of low-cost RFID tags (Liukkonen, 2015). The RFID demand is expected to grow at approximately 8% annually, and its market value is expected to reach around 28 billion by 2023 (Market, 2017). Further, the miniaturization of the technology has further enabled its application in smaller products.

Several studies have reported the benefits of RFID implementation in supply chains such as product traceability, real-time tracking, product quality assurance, and inventory management (Camdereli & Swaminathan, 2010; Liukkonen, 2015). However, which of these process benefits are acting as the key motivating factors/drivers in implementing RFID technology (referred to as benefit-drivers) is unclear, as they are fragmented and scattered across the literature. Similarly,

knowledge on the link between benefit-drivers and sustained competitive advantage is unclear. A systematic investigation, therefore, is required to understand the key benefit-drivers and its impact on organization's competitive advantage.

This formed the motivation of this study which seeks to answer the following research questions through a systematic literature review.

- (1) What are the key benefit-drivers for the implementation of RFID?
- (2) What is the relationships between benefit-drivers and sustained competitive advantage?

The answers to the above questions would be useful for practitioners and policymakers to understand the opportunities afforded by RFID implementation in their supply chains. For instance, different organizations will have different motives to implement RFID. For instance, drivers for some firms will be on improving customer service while for others it could be increasing profitability. Therefore, a clear categorization of benefit-drivers as 1) Corporate-driven and 2) Customer-driven benefit is likely to provide more impetus for firms to implement RFID technology in their supply chains in line with their organizational goals. Finally, a verifiable link between benefits and competitive advantage is important as organization may be looking to prioritize the implementation of RFID technology that gives them specific competitive advantage through process improvement benefits.

The remainder of this paper is organized as follows: In the next section, we discuss the methodology used for the systematic literature review including how research articles are collected, categorized and synthesized. The key findings from the systematic review in line with the research questions are presented in section three. We conclude in section four outlining the future research agenda, implications and limitations of this work.

## 2. Methodology

A systematic literature review process, as per Denyer et al. (2009) was followed, which consisted of the following steps: material collection, categorization, and synthesis.

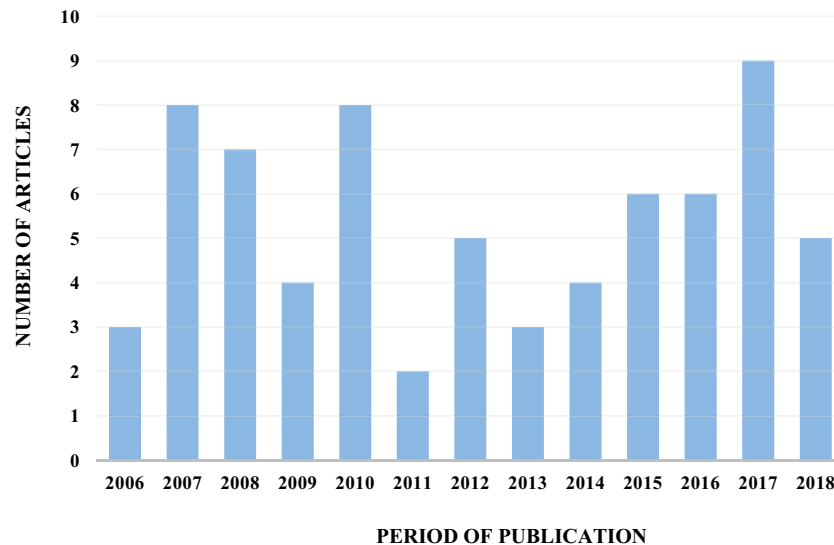
### 2.1. Research articles collection

The systematic literature review of this study was conducted using electronic databases of published studies between 2006 and 2018. The time frame chosen reflects the period that has seen significant RFID technology adoption across the supply chain. The literature search was limited to articles published in English, in peer-reviewed academic journals. The keywords used to search for titles or topics include: *supply chain management, RFID, radio frequency identification, benefits of RFID in a supply chain, RFID adoption in a supply chain, driver of implementation RFID in a supply chain, customer value from RFID adoption in a supply chain, competitive advantage from RFID adoption in a supply chain*. Using the above procedure, a total of 147 articles were initially compiled. Then, after a preliminary analysis of the articles, based on the study objectives, the list was reduced to a total of 68 articles that was deemed appropriate for detailed examination.

Figure 1 shows the number of articles by year of publication. Many of the articles were published between the years 2007 and 2010 with a second cluster after the year 2015. The categorization of articles in terms of a time frame is important as it helps in analyzing progress in the published articles by different authors as RFID technology advanced with time. We assume the high number of studies in the first cluster was due to the fact RFID was considered as a disruptive innovation during that time (Krotov & Junglas, 2008). The relatively high number of papers in the second cluster is likely due to the increase in RFID application in supply chains due to significant reduction in the cost of the technology.

Figure 2 shows the number of articles in each journal. The 68 articles considered for analysis were collected from a total of 37 journals.

**Figure 1. Distribution of articles by year of publication.**



## **2.2. Categorization and synthesis of research articles**

The articles were categorized in line with our research questions. Hence, each article was categorized as per the key RFID application benefit-drivers and competitive advantage reported in it. A detailed content analysis was undertaken to get detailed, meaningful and generalizable insights on each benefit-driver, and competitive advantage of RFID application.

## **3. Analysis and findings**

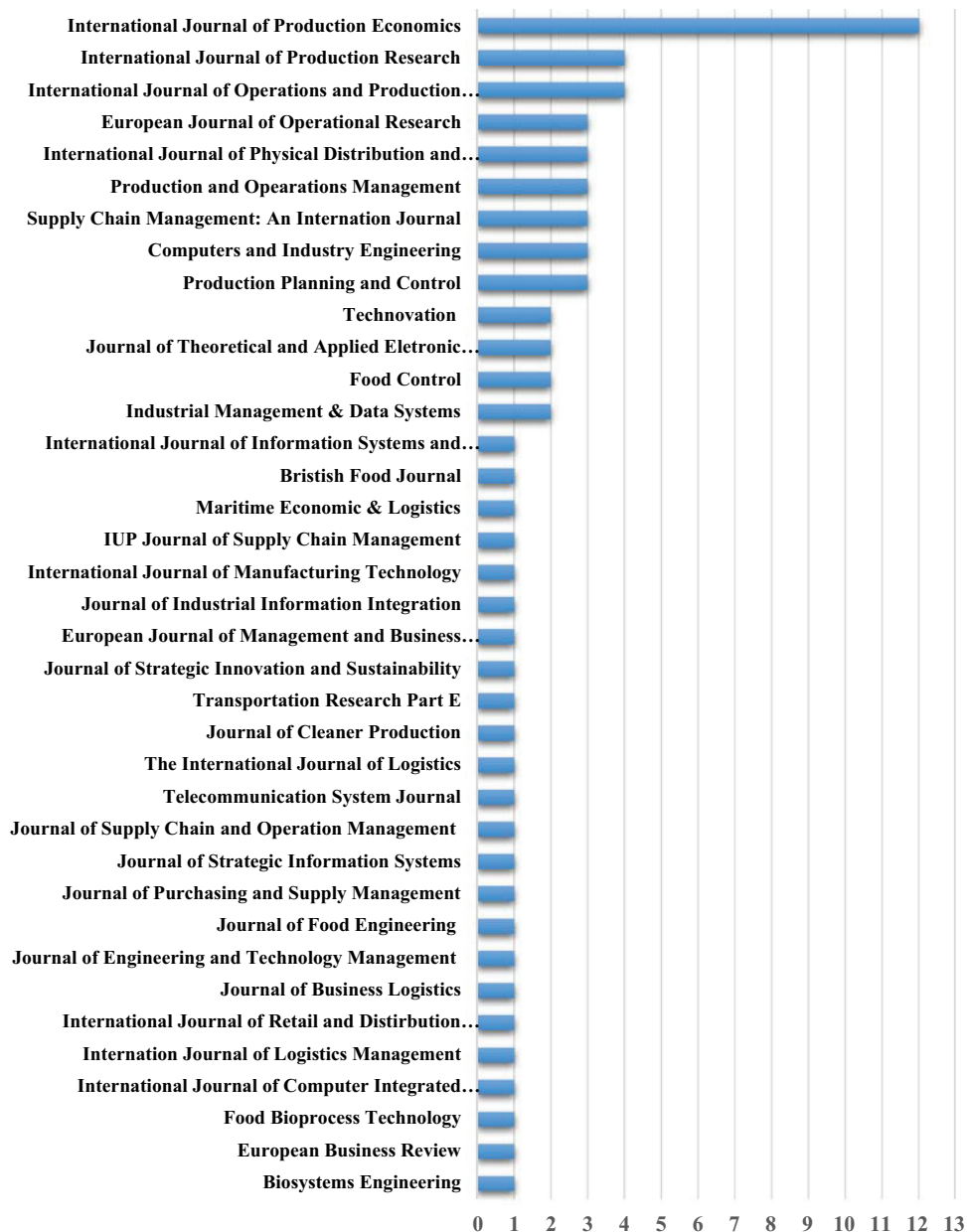
### **3.1. Application of RFID in supply chains**

RFID is technology that is being progressively adopted in supply chains as a traceability tool to integrate real-time information in order to improve operational efficiency (Sarac et al., 2010; Zhu et al., 2012). According to Becker et al., (2010), “RFID is aimed at automatic identification of objects, by storing data on tags (located on, e.g. products) and remotely retrieving these data via radio waves using RFID transponders within companies, supply chains or international supply networks.”

RFID technology consists of an RFID tag and RFID reader which are linked to a network of computers that store and process information. There are three components of each RFID-based information management system, the RFID tag, the RFID antenna and reader, and the information software management system. Information retrieved from the chip in the RFID tag will be transmitted to the reader via the antenna (Zhu et al., 2012) which uses electromagnetic fields to identify and track products by the RFID identification numbers stored in the chip of the RFID. The RFID reader then sends the data to the RFID reader which transfers it to the company's information management system such as ERP (Liukkonen, 2015). There are two types of RFID system, active and passive. Active RFID has an internal battery and is generally used in secure access control systems in the oil and gas, and mining industries as these tags can send information every few seconds and are highly efficient in operation (Zhu et al., 2012). Unlike active RFID, passive RFID has no internal power. It can only respond to a signal from the RFID reader and antenna.

Another advantage of RFID over other traceability devices is the ability to withstand harsh environments. RFID tags are durable and can be read through almost all non-metallic material and in extremes of hot weather (Attaran, 2012). This durability is a major factor in favor of industries adopting RFID rather than barcodes which tend to deteriorate in adverse weather conditions (Fu et al., 2015).

**Figure 2. Distribution of articles by journal publication.**



### 3.2. The key benefit-drivers for implementing RFID

RFID can be used in a variety of applications in supply chain management. This section discusses the key benefits from RFID implementation that is driving/motivation firms to implement it. Table 1 shows the benefit-drivers identified from each article. As seen in the table, there are six major benefit-driver identified for RFID implementation in the supply chain. They are: 1) to reduce costs; 2) to increase product quality and safety; 3) to reduce inventory discrepancy; 4) to enhance real-time information sharing and integration; 5) to increase supply chain visibility; and 6) to capture a large volume of data for analytics. Each of these is discussed in detail in the following sections.

#### 3.2.1. To reduce costs

To “reduce cost” emerged as the second-most important driver for implementing RFID after the driver to “increase supply chain visibility”. As seen in Table 1, 29 out of the 68 studies have highlighted cost reduction as one of the key drivers of RFID implementation. While most studies

**Table 1. Key benefit-drivers for implementing RFID**

	To reduce costs	To increase product quality and safety	To reduce inventory discrepancy	To enhance real-time information sharing and integration	To increase supply chain visibility	To capture volume of data for data analytics
Spekman and Sweeney (2006)				X		
Vijayaraman and Osyk (2006)	X		X		X	
Wu et al. (2006)	X				X	
Thomas et al. (2007)	X			X	X	
Chow et al. (2007)	X				X	
H. Lee and Ozer (2007)	X		X		X	
Sellitto et al. (2007)				X	X	
Tajima (2007)			X	X	X	
Cannon et al. (2008)	X	X				
Soon and Gutierrez (2008)	X		X		X	
Szmerekovsky and Zhang (2008)			X			
Krotov and Junglas (2008)				X		
White et al. (2008)	X		X		X	
Fosso Wamba et al. (2008)				X	X	
Ross et al. (2009)					X	
Veronneau and Roy (2009)	X		X		X	
Visich et al. (2009)				X	X	
Wang et al. (2009)		X				
Zhou (2009)	X	X			X	

(Continued)

**Table 1. (Continued)**

	To reduce costs	To increase product quality and safety	To reduce inventory discrepancy	To enhance real-time information sharing and integration	To increase supply chain visibility	To capture volume of data for data analytics
Camdereli and Swaminathan (2010)				X		X
Becker et al.(2010)				X		
Ferrer et al. (2010)	X	X				
Irani et al. (2010)	X	X		X		
I. Lee and Lee (2010)						
Sarac et al. (2010)			X	X		X
Sari (2010)						X
Smart et al. (2010)				X		
Kros et al. (2011)		X				
Thiesse et al. (2011)		X				
Tse and Tan (2012)		X				X
Azuara et al. (2012)		X				X
Dai and Tseng (2012)	X		X			X
Zelbst et al. (2012)		X				X
Permala et al. (2012)	X			X		X
Zhu et al. (2012)			X			X
Attaran (2012)	X	X				X
Costa et al. (2013)		X				
Piramuthu et al. (2013)		X				X
Bosona and Gebresenbet (2013)	X	X				X
Dabbene et al. (2014)	X	X				X
Barge et al. (2014)	X	X				X

(Continued)



**Table 1. (Continued)**

	To reduce costs	To increase product quality and safety	To reduce inventory discrepancy	To enhance real-time information sharing and integration	To increase supply chain visibility	To capture volume of data for data analytics
Aung and Chang (2014)	X	X			X	
Sarpong (2014)	X	X				
Aiello et al. (2015)	X	X			X	
Dai et al. (2015)	X	X			X	
Jakkhupan et al. (2015)					X	
Fan et al. (2015)			X		X	
Moon Gyu et al. (2015)						
Fu et al. (2015)	X		X	X	X	
Liukkonen (2015)			X	X		
Reyes et al. (2016)		X		X		
Alyahya et al. (2016)	X		X			
Zhong et al. (2016)				X		X
Valverde and Talla (2016)						
Mohammed and Wang (2017)	X	X				
Lamba and Singh (2017)				X	X	X
Cui et al. (2017)			X	X		
Tsao et al. (2017)	X					
Li et al. (2017)				X		X
Gautam et al. (2017)	X	X				
Majeed and Rupasinghe (2017)	X			X	X	X
Werthmann et al. (2017)				X	X	X

(Continued)

**Table 1. (Continued)**

	To reduce costs	To increase product quality and safety	To reduce inventory discrepancy	To enhance real-time information sharing and integration	To increase supply chain visibility	To capture volume of data for data analytics
Kohli and Peng (2017)		X		X		
Zhang et al. (2018)			X			
O'Bannon and McMurtrey (2018)				X	X	
Mejjaoui and Babiceanu (2018)	X			X	X	
Oghazi et al. (2018)				X	X	
Biswal et al. (2018)			X			

in Table 1 failed to report specific cost reduction benefits as they only mentioned the overall cost reduction, some studies have reported specific cost reduction such as cost reduction associated with stock out costs and cost savings associated with defects (Vijayaraman & Osyk, 2006). One of the major cost-saving potentials of RFID that is discussed in multiple studies is the labour cost reduction potential. This is largely because RFID tags can be read automatically without any labor intervention unlike other technologies such as barcode or QR code (Soon & Gutierrez, 2008; VÉronneau & Roy, 2009). For instance, H. Lee and Ozer (2007) found that the labor cost-savings potential from RFID implementation in retail sector could be as high as 30% from operations costs associated with receiving, picking, stocking, cycle counting, and physical inventory count, among others. In addition, Dai and Tseng (2012) highlighted the reduction in purchasing costs and inventory shortage costs from RFID implementation. The purchasing costs can be reduced because of the ability of RFID to enhance supply chain visibility which in turn will improve inventory accuracy. Apart from direct cost reduction in a supply chain such as labor costs and operation costs, RFID can increase the transparency and visibility of the supply chain which will reduce inventory discrepancy and increase accuracy in forecasting demand. These reductions will contribute to a further reduction in inventory costs and other costs related to holding and ordering costs in the supply chain. Although, RFID has proven beneficial for organizations, supply chain managers have to tradeoff between implementation cost and the benefits resulting from adoption of new technology. In the early stages of RFID's introduction, implementation costs were high but these have decreased as the technology has matured (Kros et al., 2011).

### 3.2.2. *To improve product quality and safety*

As seen in Table 1, 23 out of the 68 studies have highlighted “to improve product quality and safety” as one of the key driver of RFID implementation. This is because RFID technology is increasingly being used in various industries with the aim of achieving the highest quality and safety standards of product and service. For example, RFID applications in healthcare are used to match blood samples with patients. In the healthcare sector, accuracy in matching these samples with the correct patient is critical and RFID has proven to be the best means of achieving this objective (Attaran, 2012). In addition, it can also apply in medical equipment and medication management to ensure that patients are given the right dose of the right medication at the right time. RFID can also be used with Blockchain technology in the healthcare industry for traceability (Chanchaichujit et al., 2019a).

Apart from healthcare, Kros et al. (2011) and Thiesse et al. (2011) found that RFID is an important tool when implemented in the manufacturing industry to improve product quality by accurately identifying the faulty ones.

Traceability is essential to ensure product quality and safety, particularly in the food and beverage industry. Food quality and safety standards are important issues around the world as they impact public health. It was estimated in Australia that there are approximately 11,500 cases of food poisoning every day, which costs approximately 2.6 billion Australian dollars annually (Aung & Chang, 2014). Another example of food poisoning in China resulted from melamine residuals found in baby milk formula from Chinese manufacturers (FAO, 2020). Hence, the need to safeguard consumers' health through traceability systems and verifying the quality of products is one of the successful and essential supply chain management application afforded by RFID (Sarpong, 2014; Tse & Tan, 2012). Traceability tools provide confidence for customers to ensure that the products and services they are consuming are safe and meet a standard quality in accordance with government rules and regulations (Aung & Chang, 2014; Biswal et al., 2018; Costa et al., 2013). Given that rules and regulations related to food quality and safety are made stringent by governments around the world, application of RFID is critical for food companies to monitor and control their products along the supply chain including reverse logistics and product recalls. Researchers have noted that for product recalls, food suppliers have to utilize traceability tools to allow backward tracking of deficient products to identify the origin of the problem, in conjunction with forward tracking to withdraw potentially defective products from the same

production batches without any delay (Dabbene et al., 2014). Efficient traceability tools can manage product recalls effectively under demanding time and resource constraints to reduce the negative impact on the supplier resulting from customer complaints (Aiello et al., 2015). These values can be passed on to customers in order to increase customer satisfaction and loyalty to products and services of the organization (Kros et al., 2011). RFID technology not only has an impact on healthcare and food industries, but also has an impact on various industries that wish to survey their customers and incorporate customer feedback into their business strategies. This will ultimately enhance customer confidence in the organization's products and services (Aiello et al., 2015; Aung & Chang, 2014; Dabbene et al., 2014).

### 3.2.3. *To improve inventory discrepancy*

A total of 20 studies have reported this as a driver of RFID. RFID can be implemented for inventory control to track raw material, work in progress and assembly status of the material being used on the production and assembly line (Lim et al., 2013). Inventory discrepancy is one of the biggest problems in supply chains despite most business processes being automated. Inventory discrepancy is defined as the difference between actual on-hand inventory levels and the IT system-recorded inventory level. The higher the inventory discrepancy, the lower the business performance from lost sales, over-stocking of inventory and poor customer service. Sarac et al. (2010) found that there are four causes of inventory discrepancy; 1) Transaction error, 2) Shrinkage error, 3) Inaccessible inventory error, and 4) Supply error. Transaction errors refer to errors resulting from shipment inaccuracies, incorrect item identification and scanning errors. Shrinkage error, a leading cause of discrepancy in retail industry, refers to the loss of products which are ready to deliver to customer and could result from a variety of reasons such as clerical errors, shoplifting, employee theft or supply fraud (H. Lee & Ozer, 2007). A study by Biswal et al. (2018) found that RFID can reduce inventory inaccuracy especially inventory shrinkage and misplacement. Another area of inventory discrepancy is the inaccessible inventory error. It occurs when inventory items are not located at the right place and hence are not available when the customer needs them (Liukkonen, 2015). Sarac et al. (2010) mentioned that lower product quality and yield efficiency are considered to be undersupply errors. RFID can address these errors. For instance, it provides better visibility and traceability to align actual on-hand inventory records to a system records inventory level, thus reducing inventory inaccuracy in the supply chain (Dai & Tseng, 2012). Although RFID may not resolve all the inventory discrepancies mentioned above, but it can help to detect issues at an early stage for supply chain managers to maintain effective inventory control. Also, there is ample evidence supported from the literature (Kros et al., 2011; Thiesse et al., 2011) that RFID applications can help reduce waste in manufacturing based on their tracking ability to move the right amount of the right material to the right place at the right time (Zelbst et al., 2012). In terms of inventory control and warehouse management, RFID allows real-time tracking and tracing of items in order to reduce the prevalence of counterfeit products and reduce product theft in retail stores (Sellitto et al., 2007; Soon & Gutierrez, 2008). It is important for organizations to detect and monitor their products if they are to maintain customer satisfaction. Attaran (2012) and Soon and Gutierrez (2008) pointed out that RFID is an effective solution to handle this problem. Ferrer et al. (2010) also found that this solution can contribute to enhanced accuracy in inventory control and warehouse management systems, thus improving overall operations performance and customer service (Cannella et al., 2015). Adding to the efficiency, RFID chips, unlike barcodes, can be read from a distance of several meters and out of the line-of-sight. Chips, therefore, do not need to be placed in a precise position for the RFID reader (Sari, 2010). The removal of constraints related to line-of-sight ensures higher accuracy of information compared to barcode scanning systems in the supply chain.

### 3.2.4. *To enhance real time information sharing and integration*

To "increase real time information sharing and integration" emerged as the third-most important driver for implementing RFID. As seen in Table 1, 26 out of the 68 studies have highlighted this as one of the key drivers of RFID implementation. Since the information that is gathered from RFID is real-time, the product status can be tracked and traced anywhere and at any time to streamline

business processes with a low turnover time (Sari, 2010). Becker et al. (2010) found that information timeliness enhances business process information by providing in-depth and accurate information. In addition, supply chain lead times will be decreased as information is processed at a faster rate. This can lead to improved accuracy of the supply chain information-sharing to enhance supply chain members' information integration (Krotov & Junglas, 2008; H. Lee & Ozer, 2007). In terms of decision-making, real-time information sharing provides decision makers with accurate information to make faster and better decisions. Each supply chain member can coordinate and disseminate the required information, thereby providing a transparent view of the entire supply chain (Soon & Gutierrez, 2008). Smart et al. (2010) suggested that to unlock the potential of RFID beyond the boundaries of an organization, supply network members need to work together to allow each other to access the data generated by the use of RFID. Thus, when RFID technology is adopted in a supply chain, it is likely to enhance transparency in data sharing among supply chain members. This in turn will contribute to an enhanced trust and commitment for all stakeholders and thus provide value and mutual benefit to all supply chain members (Kros et al., 2011; Sari, 2010; Spekman & Sweeney, 2006). This creates a win-win situation for all those involved in supply chain management (Cannon et al., 2008).

White et al. (2008) mentioned that information management in a supply chain is vital to increase customer satisfaction level. In addition, the literature shows that lack of information sharing in supply chain may cause the bullwhip effect, i.e., the phenomenon of small fluctuations in demand at the retail level causing progressively larger fluctuations in demand at the wholesale, distributor, manufacturer and raw material supplier levels (Costa et al., 2013; H. Lee & Ozer, 2007; VÈronneau & Roy, 2009). Information sharing via RFID in a supply chain can, therefore, increase information coordination and transparency which reduces the bullwhip effect, minimizing uncertainty and risks in the global supply chain. Due to globalization, outsourcing is one of the key strategies for an organization seeking competitiveness. When a supply chain is expanding into a global supply chain, the level of complexity and risk increases. RFID can be adopted to address this issue by providing real-time information sharing and integration. Moreover, RFID is now part of the Internet of Things (IOTs) which allows all members in the network to access real-time tracking of their global supply chain (Ngai et al., 2008).

### 3.2.5. To increase supply chain visibility

To "enhance supply chain visibility" emerged as the most important driver for implementing RFID. As seen in Table 1, 41 out of the 68 studies have highlighted this as one of the key drivers of RFID implementation. Francis (2008) has discussed definitions and terms used to define supply chain visibility in various collection databases and proposed the definition of supply chain visibility as "*the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/time for these events*". From the above definition, the author has identified as entities any objects moving through the supply chain which includes items, packaging, customer orders, shipments, assets or vehicles. The capability of sharing timely and accurate information has been supported in various publications to strengthen supply chain performance (Williams et al., 2013; Yu & Goh, 2014). In addition, Williams et al. (2013) pointed out that real-time information sharing and supply chain visibility are a dual-pronged approach driving an organization to achieve supply chain responsiveness which will lead to enhanced organization competitiveness. Another benefit from supply chain visibility is the improvement of sales forecast accuracy which results in cost reduction in inventory management, manufacturing processes and asset management (H. Lee & Ozer, 2007; Soon & Gutierrez, 2008). Moreover, the findings of Dai and Tseng (2012) supplement those of H. Lee and Ozer (2007) and Soon and Gutierrez (2008) on error reduction, showing that supply chain visibility not only reduces errors but also provides information to detect errors in a timely manner. Once supply chain visibility is utilized with preventive action strategies, therefore, cost-savings potential can be achieved (Dai & Tseng, 2012). Furthermore, Szmerekovsky and Zhang (2008) proposed that the most significant benefit of adopting RFID is not only to increase supply chain visibility but also the ability to increase customer satisfaction. In terms of supplier relationship management, RFID can help achieve cost optimization of new materials and reduces

the need to find new suppliers. RFID-enabled traceability can improve information quality and therefore can improve supply chain collaboration and supplier relationship management. (Barge et al., 2014; Dai et al., 2015; Zhou, 2009). Finally, Aiello et al. (2015) found that when a supply chain implements an RFID-enabled traceability solution, it usually results in an increase in overall profits.

### 3.2.6. *To capture an appropriate volume of data for analytics*

This emerged as the least reported driver of RFID implementation. As seen in Table 1, only five studies have mentioned this as a driver of RFID implementation. This is because, it is a recent driver, which was first mentioned in 2016 (Zhong et al., 2016). However, we expect this to be major driver in the coming years given the increasing importance of big data and data analytics. RFID provides an opportunity for a business to acquire a large quantity of data from its supply chain through its ability to capture and transmit data in real-time. These data can be utilized to gain useful insights towards optimizing organization decision making (Lamba & Singh, 2017). There are many successful case studies identified from this systematic literature review that shows how RFID can be adopted with various technologies and enterprise solutions for big data analytics such as Enterprise Resource Planning (ERP) (Oghazi et al., 2018), Electronic Data Interchange (EDI) (Lamba & Singh, 2017; Werthmann et al., 2017), IoT and cloud manufacturing (Li et al., 2017; Majeed & Rupasinghe, 2017; Zhong et al., 2016), and sensor or other wireless communication devices (Alyahya et al., 2016; Mejjajouli & Babiceanu, 2018). The research by Oghazi et al. (2018) investigated the impact of integrated ERP and RFID in supply chain management. The authors found that this integration can improve supply chain information integration, especially financial information flow. In addition, the work of Fosso Wamba et al. (2016) on RFID implementation in the supply chain supported the research of Oghazi et al. (2018) and added that the integration of RFID and ERP can be used in a company for better supply chain strategies and synergies through better analytics. To transform and upgrade the traditional supply chain to industry 4.0, RFID plays an important role to integrate with IoT and cloud manufacturing. Li et al. (2017) investigated the implementation of RFID and IoT-based tracking platforms for real-time data collection and information sharing for pre-packaged food supply chains. The authors conclude that this platform enhances information-sharing among all stakeholders and finally increases product quality and safety. Zhong et al. (2016) added that a combined solution of RFID and cloud manufacturing can be used for large-scale data analytics. In addition Majeed and Rupasinghe (2017) stated that RFID's ability to capture and disseminate real-time information across the supply chain provided customer insights that helped improve organization's products and services.

Overall, the above sections answered the research question 1 on the key benefit-drivers of RFID implementation.

### 3.3. *Categorization of benefit-drivers for implementing RFID as customer-driven and organizational-driven*

From a systematic literature review it can be concluded that the key drivers of RFID implementation in a supply chain can be categorized as corporate-driven and customer-driven. The corporate-driven drivers are those that enable organizations to be successful in network co-ordination, enable supply chain partners to develop trust and collaboration along the chain while improving inventory visibility of their products and information flow in real time (Jacoby, 2010). The corporate-driven drivers include cost reduction, inventory discrepancy reduction and the ability to capture significant data for data analytics. This is important because organizations can operate only a few key activities which are core to their business and rely on supply chain partners for other activities. Importantly, corporate-driven elements focus on how RFID implementation could lead to supply chain profitability.

On the other hand, from a customer-driven standpoint, customers are increasingly demanding higher product quality and safety. Hence, there is a need for accurate product traceability and give the customer's product information in a timely manner. Customer-driven elements focus on how RFID helps in adhering to and meeting customer requirements. The customer-driven drivers

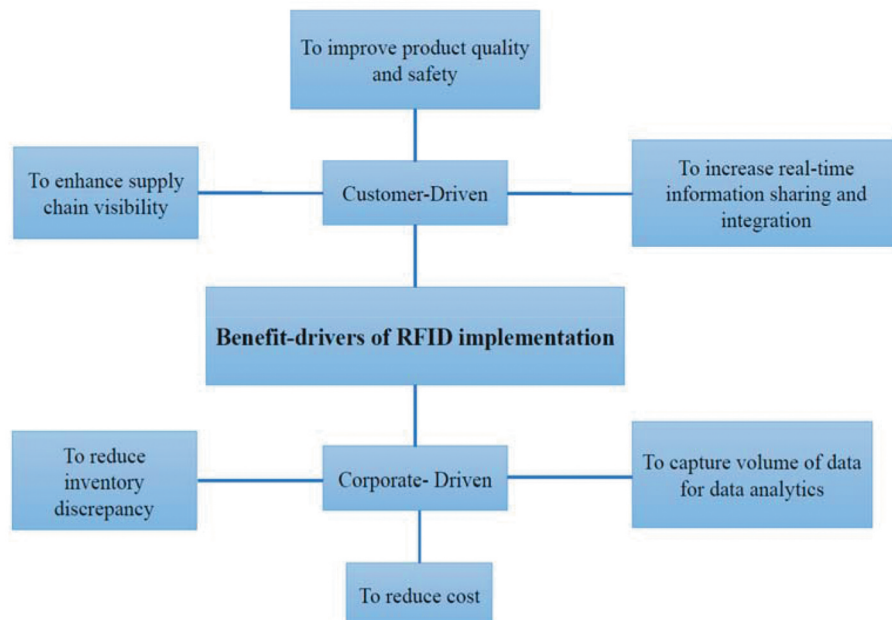
include product quality and safety, supply chain visibility and real-time information sharing and integration. Technology tools, therefore, particularly RFID, are important to enable supply chain traceability and to support an organization for strengthening customer relationships.

In sum, we propose the “2 C” categorization of drivers of RFID implementation in the supply chain as shown in Figure 3. As mentioned, the first C is customer-driven and the second C is corporate-driven. This categorization can be used to better understand firm motives in implementing RFID in their supply chain and subsequent achievement of competitive advantage.

### 3.4. The relationship between benefit-drivers and organizational competitive advantage

Technological advancements are proving to be the backbone of any competitive industry. Both Visich et al. (2009) and Attaran (2012) posited that technology has proven to be one of the deciding factors ensuring that companies remain competitive. It is important to understand, however, that technology is only a facilitator and not the front-runner conducting the business. Visich et al. (2009) stated that business processes should be streamlined through the use of business strategy leveraging technology to meet business objectives. RFID technology is a facilitator in making the supply chain responsive and traceable from the point of origin to the point of consumption. In addition, RFID technology has given a competitive edge to organizations and partners in the supply chain not only in cost saving (Soon & Gutierrez, 2008; Visich et al., 2009) but also offering products that meet customer requirements. By doing this, added value will be created for businesses to attract new customers and encourage higher customer retention. As explained above, there are many benefits that motivate organizations to implement RFID. However, along with these benefits, they also are motivated by the long-term prospects of sustained competitive advantage. In other words, organization may implement RFID not only with the objective of increasing product quality and safety, but also increased customer satisfaction and loyalty that will give them competitive advantage over business rivals. Different benefits can lead to different competitive advantages, hence this research has mapped and proposed the competitive advantage from adopting RFID in a supply chain in order to link the benefit-drivers with various competitive advantage.

**Figure 3. The 2 C driver-benefits of RFID implementation (developed by the authors).**



**Figure 4. Framework of RFID benefit-drivers and competitive advantage (Developed by the author).**

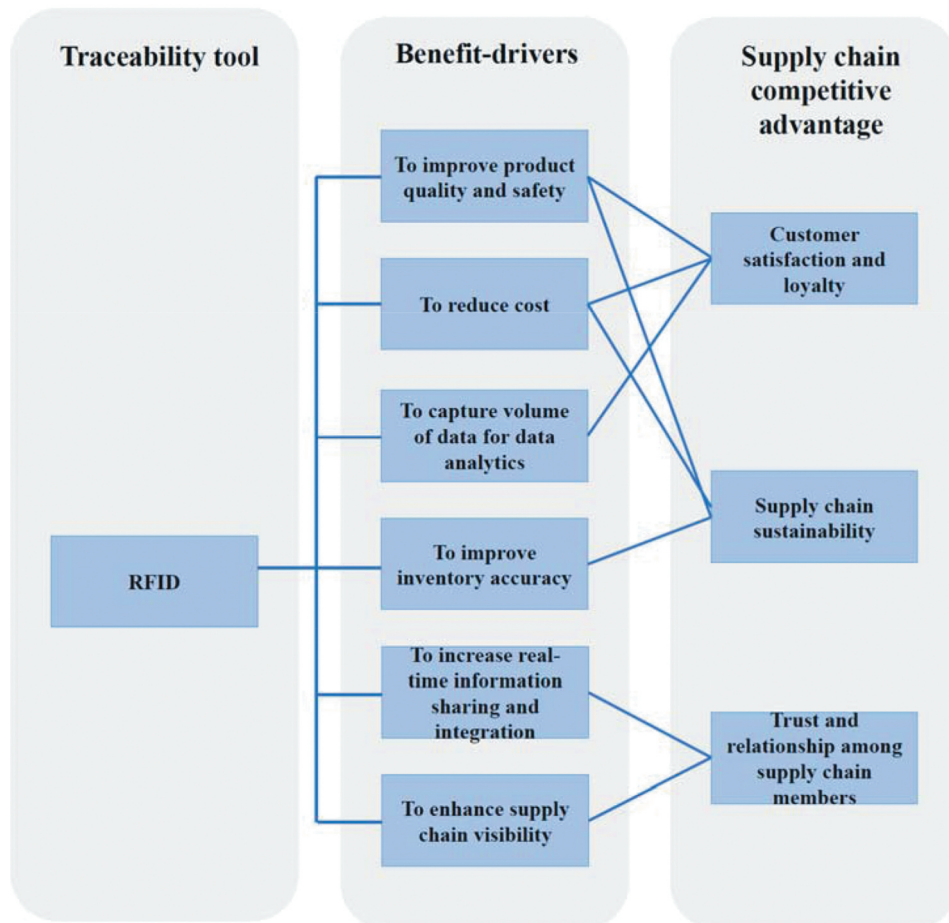


Figure 4 shows a framework of supply chain competitive advantages resulting from the adoption of RFID in a supply chain. It was identified from the review that when adopting RFID in a supply chain as a traceability tool, an organization's competitive advantage will be increased mainly in three aspects. These are:

1) Customer satisfaction and loyalty, 2) Supply chain sustainability and 3) Trust and relationship among supply chain members. Customer satisfaction and loyalty will increase when there are improvements in product quality and safety to meet their ever-changing quality standards, as well as lowered prices of products due to reduced production costs. In addition, with data being the new oil of the economy, the ability to capture significant data for the analysis can help a company to acquire customer insights in order to provide products and services to meet customer expectations. To enhance supply chain sustainability, quality and safety are critical. These are achieved through RFID implementation such as through improvement in inventory accuracy and cost competition. Finally, RFID instills trust through the sharing of real-time information and integration. As mentioned in Cannon et al. (2008), increased visibility creates trust among members of the supply chain by allowing them to work in close collaboration with one another and enabling them to access critical information to ensure customer satisfaction.

With the proposed framework, we answered the research question 2 on the relationship between key benefit-drivers and competitive advantage of RFID implementation.



#### **4. Conclusion and future research agenda**

This paper presents a systematic literature review of supply chain management, focusing in particular on RFID's vital role in managing a supply chain. This has been achieved by reviewing a total of 68 journal articles from 37 leading supply chain and technologies journal articles between the year 2006 and 2018. The aim of this research is to understand the key benefit-drivers and the ways in which they enhance competitive advantage. The study found six major benefit-drivers for RFID implementation in supply chain which are categorized as customer-driven and corporate-driven benefit-drivers. The customer-driven element focuses on the ways in which traceability helps in adhering to and meeting customer requirements while corporate-driven element focuses on the ways in which traceability can lead to supply chain profitability. Further, the study developed a framework for better understanding the ways in which benefit-drivers associated with RFID implementation can lead to different competitive advantages. The study findings and the framework provide a good starting point for academics and practitioners to further explore the opportunities in supply chain afforded by RFID implementation. Hence we propose the following future research agenda.

##### **4.1. Future research agenda**

As seen in Table 1, none of the studies have looked at all six benefit-drivers in their studies. A holistic orientation is required in future research to study all benefit-drivers together to understand the relative importance of these drivers. Next, compared to the various drivers, more research is required to understand the motive of firms to implement RFID technology with the objective of generating large volume of data for analytics. Compared to other drivers, only limited studies have investigated this driver. Further, more in-depth investigation, preferably, case studies and interview-based studies to gain deeper insights within each of the benefit-drivers so that sub-dimensions can be better understood. For instance, in the case of cost reduction as a driver, there are multiple opportunities to reduce cost from RFID implementation such as labour costs, purchasing costs, inventory cost, and cost of defects among others. Similarly, sub-dimensions of other benefit-drivers could be understood. In the case of generating large volume of data, future research could explore the common data generation points and its significance, such as data generated from warehouse and data during transportation/transit. This study only proposed a theoretical framework capturing the potential relationship between benefit-drivers and competitive advantage. Future researchers should try to operationalize the six driver-benefits and the three performance competitive advantage aspects identified in this study as a multi-dimensional construct comprising sub-dimensions. Studies could then attempt to develop and validate a survey instrument to capture these constructs proposed in the framework. This would enable researchers to conduct large-scale investigation to empirically test and validate the framework and constructs, and assess the strength of the relationships between them. Construct development and validation are essential for the establishment of a common conceptual base, especially when there is a lack of agreement on how the scope of RFID is defined in the literature (Balasubramanian & Shukla, 2018). Multivariate statistical analysis such as confirmatory factor analysis and structural equation modeling should be preferably conducted on a large-scale survey data for the proposed framework to check the statistical appropriateness of the framework including the constructs and to assess the relationships between the benefits and competitive advantage. Transition from framework to formal theory occurs as frameworks are tested against reality until they are eventually developed into theories as research study builds upon research study. From a practitioner perspective, the insights on the strength of the relationship would enable firms to prioritize those RFID implementation that will help them achieve greater competitive advantage than others. For example, application of RFID to improve product quality and safety may generate more competitive advantage than say RFID application for inventory accuracy. Future research should also explore how RFID can be adopted with enterprise solutions such as ERP and recent Industry 4.0 technologies such as Internet of Things (IOTs) and Blockchain, and other sensor technologies to support data-enabled decisions in the supply chain.

The study has some limitations. First, the scope of the study was to identify the benefit-related drivers only and do not take into consideration the coercive drivers such as regulatory pressure, competitive pressure, and supplier pressure. Second, the study hasn't considered the barriers or hindrances to RFID implementation. For future research, it would be useful to understand the impact of various barriers such as lack of knowledge and awareness, and upfront cost of implementation. The proposed framework can be expanded with these antecedents.

Despite the limitation, the contributions of this study including the framework considerably fill the gap in the literature and provide a starting point for academics and practitioners to further explore the opportunities in supply chain afforded by RFID implementation.

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