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Technological Innovation Applied to Walmart and Tesco's Supply Chain

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Abstract

This paper aims to analyze technological innovation applied to retailing supply chain. The research consisted of a brief overview of the state of current technologies and their development throughout time, as well as recent trials and perspectives of advancements for the future. Further, an analysis of two specific retailers – Walmart and Tesco – was performed to identify and address where such innovations are being applied in real scenarios, ultimately revealing opportunities for a streamlined supply chain and which other benefits they offer. Finally, market and companies' financial context were analyzed, to justify either the limitation or extent of technological development.

Keywords: Supply Chain; Technology; Walmart; Tesco

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1. Introduction

Context. In a globalized economy, companies are pursuing cost reduction while adding value to their final products through their supply chain strategies. Whilst in the past competitive advantage could be attained by focusing on the four Ps (product, price, promotion and place), to prosper in the current scenario profound changes ought to be made in the organization's culture and practices, adopting the latest technologies to address market needs (Waters, 2010). An interesting approach developed by Donald J. Waters shifts that somewhat outdated look at supply chain management and operations to a new formula, known as the four Rs (reliability, responsiveness, resilience and relationships). Regarding the latter, this is an especially relevant aspect for retailers, as a collaborative approach is now the norm: a long-term buying perspective currently considers total costs involved in the buying process, including technological investment from both vendors and retailers (Zentes et al., 2007).

2. Methodology

The research methodology combines both qualitative and quantitative data. The qualitative research consists mainly in two case studies, i.e. comparison of two realities – Walmart and Tesco – by using the most recent peer-reviewed articles regarding current technologies and transformations in SCM, mostly from within the past five years, and further assessing their impacts specifically in the organizations' procedures. Academic literature found in books, specialized retail and supply chain magazines and websites will also be used. Quantitative research is done through secondary source of information analysis, especially number of stores, profit margins, revenue growth and market share from reliable data collected about both retailers in the past decade.

The report will be divided into six chapters. In chapter 3, Literature Review, the most recent peer-reviewed articles and books – primarily from the past five years – will be used to identify technological development in supply chain management, especially in retailing. Contrasting opinions from renowned experts regarding the benefits and possible applications of those technologies will be exposed, as well as possible disagreements amongst authors either in definition, applications and benefits of technologies. In chapter 4, Development, firstly the criteria for choosing both retailers – Walmart and Tesco – will be clarified, as well as current state of technological development in the retailers' supply chain. The approach will be to separately analyze individual technologies and their impact in each of the organizations' supply chain to further propose a comparison amongst both retailers' innovations, allowing, ultimately, the understanding and reasoning behind each company's strategy. Throughout this report, it is intended that the research questions below are answered. The outcome of these research questions will be disclosed in chapter 5 (Conclusion) preceding the debate, which will then summarize the report, while introducing prospects for further research.

Research Questions: Q1: How is current technology being applied and in which ways it has improved supply chain performance for Walmart and Tesco? Q2: How do Walmart and Tesco achieve technological improvements in their supply chain? Q3: In which ways technological improvements in Walmart and Tesco's supply chain differentiate and why?

3. Literature Review

Retailers are recognizing that a shift of procedure and organizational mindset is necessary to succeed in the current market. Focusing exclusively on improving internal processes and efficiency is no longer enough to keep a competitive advantage. Managing its supply chain sustainably is imperative to reduce costs and increase agility, making the most out of the scarce resources available (Ansari and Qureshi, 2015). The development of this sustainable modern

supply chain can be assisted by current technological innovations. Web technologies, for instance, have been used to improve the supply chain of numerous organizations such as Walmart, Dell and Intel by providing electronic payment systems, aiding on inventory management and procurement, overall streamlining their supply chain (Tarofder et al., 2013).

Radio frequency identification (RFID) implementation has also been a tendency in SCM. It is regarded as the "next big impact" after the barcode and it mainly consists in wireless communication between a RFID tag and a reader, through radio frequency (Mejjaouli and Babiceanu, 2015). Authors agree on the main benefits of this technology, e.g. providing real time data and improving visibility (Mejjaouli & Babiceanu, 2015) and reducing "inefficiency of inventory inaccuracies" (Fan et al., 2015:125) as a result of an "improved inventory management accuracy and responsiveness through real time inventory information" (Shin & Eksioglu, 2014: 637). Decrease in labor costs could also be considered, as there is a decline in inventory counting and product scanning error rates (Shin & Eksioglu, 2014). However, "no customer demand" and "lack of ROI" were considered the main reasons for companies not to implement RFID (Osyk et al, 2012: 912). For retailers specifically, the high cost associated with implementing the technology was also a barrier for RFID adoption, alongside with the perception that the technology is still immature (Osyk et al, 2012). This led to a reluctance in suppliers to adopt the new technology, despite the aggressive strategy of some retailers (e.g. Walmart) to impose harsh penalties on suppliers, as it did not provide them with necessary guidance and support (Feng et al., 2014).

Big Data has also been another major trend in SCM. It was estimated that Walmart was collecting roughly 2,5 petabytes of data every hour from customers' transactions in 2012 (McAfee & Brynjolfsson, 2012). However, when it comes to Big Data and data analytics, authors have come up with contrasting definitions. McKinsey Global Institute's researchers

address it as “datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze” (Manyika et al., 2011:1). Pries & Dunnigan., on the other hand, have a more comprehensive interpretation on the Big Data phenomenon, defining it as both “the proliferation of data (…) as the result of exponential growth in the capabilities of computer processing power (…)” and also “the computer hardware and software infrastructure that has been created to quickly and accurately draw insights from large volumes of highly variable (…) data appearing at a voluminous arrival rate” (Pries & Dunnigan, 2015: 62). Even though there is a difficulty for authors to find a common definition on what Big Data represents and its form, most managers specialized in supply chain found a common use for it: to “seize and configure resources to cope with changing trends” (Richey Jr et al., 2016: 717). Research done with top managers from several different countries shows that Big Data’s main benefits in supply chain are increasing visibility of demand and improving responsiveness (Richey Jr et al., 2016). Authors also identified practices to increase supply chain agility: Giannakis and Louis (2016:716-7) developed a multi-agent system which enhances SC agility by increasing flexibility (through faster product development, dealing with volume variability and faster adjusting in delivery capability) and increasing responsiveness (through increasing visibility and cycle time reduction and “rapid reaction and detection”). Gunasekaran et al. (2017), in turn, acknowledge that the effect Big data and Predictive analytics have in supply chain performance – by improving visibility (Barratt & Oke, 2007), resilience and robustness (Brandon-Jones et al., 2014) – can only be attained if there is commitment by top management, which will assimilate the technologies into the organization’s practices. Bradlaw et al. (2017) provided relevant insights on other aspects of Big Data in retailers’ SCM, by demonstrating the possibility of using traditional enterprise data capture (a combination of sales data from UPC scanners with inventory data from ERP and SCM software) to analyze inventory movement patterns by SKU.

Drones – and other UAVs unmanned aerial vehicles – lately have been targeted for usage both in back and front office (Blanchard et al., 2016). Although some companies such as Amazon and Domino's already started the development of such technology for delivery purposes, regulatory restrictions are limiting its trials (Collins, 2016). Despite those restrictions, Stillman (2013:27) addresses that the usage of drones in delivery of freight can be advantageous considering it avoids "trucking-specific industry issues", such as automobile accidents and highway constructions, which frequently affect timely delivery. Regarding usage in back office, drone tests have already been initiated in warehouses for cycle counting process "significantly reducing its duration", while also improving inventory accuracy, as mismatches can then be physically reviewed (Blanchard et al., 2016: 16). Vyas (2016) highlights that we may see improvement in supply chain performance by combining drones equipped with other technologies (GPS, RFID, OCR and barcode readers) to locate targeted assets in remote locations such as ports and yards, reducing both labor force and time. Although there are security concerns on using drones for delivery, as it usually leaves packages delivered more exposed, some authors such as Bamburry (2015) and Stillman (2013) focus on security improvements that could be seen with the usage of drones, both outdoors – by escorting delivery vehicles carrying high value goods – and indoors – through video surveillance in warehouses to track unauthorized entrance in restricted areas.

Managers are also adopting warehouse automation for SC improvements. This has been especially the case for e-commerce and omni-channel retailing (Sowinski, 2013). Warehouse automation can be done using specialized software, hardware or a combination of both, resulting in either a semi-automated or fully-automated warehouse (Mantey, 2016). Goods-to-person (GTP) technology is used to bring products directly to the warehouse workers, instead of having employees traveling to pick them. Examples of GTP technology are automated storage and retrieval systems (ASRS) – considered the highest level of automation – which

place and retrieve loads from defined storage locations, and shuttle-based systems that traverse aisles in warehouses to handle heavy loads (Mantey, 2016). Pick-to-light and put-to-light systems, in turn, use "lights above racks or bins to direct pickers where to pick" or place items goods, which leads to a better adjustment to and seasonal and peak demands as it "ratchet up picking capabilities (Mantey, 2016:36-7). Even though authors highlight different strategies for warehouse automation implementation, the benefits are usually alike: reducing labor dependency and costs, while avoiding labor regulations regarding amounts of weight employees can carry (Mantey, 2016 and Sowinski, 2013), improving throughput and service levels (Mantey, 2016), reducing replenishment times (Maras, 2014a/2014b and 2014/2 and Sowinski, 2013) and overall improving warehouse efficiency (Maras, 2014a/2014b; Sowinksi, 2013 and Mantey, 2016).

All in all, technology implementation in retail SCM provides opportunity for strategic planning, by allowing cost control, quality/productivity assessment and readiness for fluctuating demand (Stevenson, 2012) – practices necessary to sustain a competitive advantage. It is important to highlight, however, that this list is not exhaustive and more examples of innovation affecting retailers' supply chain will be analyzed in this paper on the following chapters.

4. Development

After assessing the current technologies used to streamline supply chains, it is imperative to analyze the direct impact they have on retailers' daily operations. For this analysis, two retailers were chosen: Walmart and Tesco. The choice of retailers was done following mainly three criteria: annual revenue, strong presence in local and global markets and distinction in SCM strategies.

According to Deloitte's 2015 report, Walmart's retail sales revenue reached more than 482 billion US dollars, making it the retail group with highest revenue worldwide. Tesco, in turn, reached more than 81 billion US dollars of retail sales, making it the 9th largest retail group worldwide and 4th outside the US (Exhibit 1). Regarding both local and global presence, the two retailers have stores located in numerous countries, while also concentrating roughly half of their operations in their home market. According to latest data provided by Walmart (n.d.), there are 11.695 stores worldwide – 4.672 of those in the U.S – as of 2017. Tesco (n.d.), in turn, has 6.809 shops worldwide – 3.739 of those in the UK (Exhibits 2a and 2b). When it comes to SCM, Tesco has taken the lead and is considered a pioneer in establishing a network of warehouses and distribution centers based on different product groups, making it one of the largest operators of a distribution network in the UK (Zentes, 2007). Walmart is also known for its supply chain innovations and lately it has been especially drawn attention to after the implementation of its analytics hub, which was perceived as a very solid way to keep track of its sales metrics and optimize its SC efforts (Marr, 2017).

Technological Innovation Applied to Walmart's SC

Walmart has been a lesson of strategic SCM for some years now, and it is important to address that, because it focuses mainly on cost leadership, "attaining the lowest end-to-end operational cost, and the highest productivity" is decisive to achieve such goal (Jacobs and Chase, 2014:670).

RFID

Strong RFID implementation efforts began in 2003, when Walmart became the first retailer to mandate its top 100 suppliers to tag "pallets and cases by January 1, 2005, with Electronic

Product Code (EPC) labels" – the world's first RFID standard (Hunt, 2007:2). The so-called RFID compliance program would then target its top 300 suppliers by the beginning of January 2006. The program failed at first in obtaining support from suppliers, which lead Walmart to charge service fee – also called a penalty – of US$2 per untagged pallet on February 2008 and increasing it to US$3 in 2009 (Feng et al., 2014). The harsh penalties, the lack of guidance and support from Walmart to its suppliers and the high costs of implementing such technology – especially when comparing to the negligible costs of barcode tags – lead vendors to protest the RFID mandate, and ultimately to Walmart's failure to implement the technology at the pace it had initially planned (Trebilcock, 2010).

Nowadays, although the company still uses RFID, it has changed its strategy drastically. Walmart is said to have lowered their penalty fees for untagged pallets to just around 12 cents and mainly uses the technology mainly in apparel or with specific suppliers. Regarding apparel, former Walmart Stores president and COO disclosed that an Electronic Product Codes program started in 3.000 stores in the U.S., which allowed for a significant reduction in time to "inventory a back room or a rack of apparel" from roughly one day to only an hour (Roberti, 2010). There are also partnerships with specific suppliers: P&G, for instance, has worked with Walmart since the late 80s with the implementation of vendor-managed inventory and continuous replenishment (Kosasi et al., 2014), as seen on Exhibit 3. Procter and Gamble was one of the first suppliers to comply with Walmart's RFID requirements in the beginning. P&G's spokesman for Global Operations said at the time that the technology streamlined the process, increasing accuracy of deliveries, reducing time for scanning items by one fourth and helped the company to better deal with fluctuating demand (Songini, 2007).

From this information, it is clear that although Walmart has not abandoned its RFID program completely, it currently focuses only in goods with higher value/margins or with specific long-lasting partnerships with strong suppliers, where there is mutual support, both parties can

clearly identify the direct benefits of the technology investment and the supplier has financial wealth to do so. As a result, the RFID implementation to position inventory, Walmart had already saved US$290 million (Jacobs and Chase, 2014).

Drones in Inventory Management and In-store delivery

Walmart reported in 2015 that although their sales had grown 4.8%, inventory grew at a much lower rate of 2.2%, which follows Walmart's objective of "shedding excess inventory". According to experts, such strategy is due to Walmart's move to e-commerce and omnichannel retailing (Chao, 2015). Drones are being tested to improve inventory management inventory and improved in-store service. The company applied in 2015 to U.S. regulators "to test drones for home delivery, curbside pickup, and conducting warehouse inventory checks" (Material Handling & Logistics, 2015), and this year it has filed a patent for moving products inside its stores (Vanian, 2017), as seen on Exhibit 4.

Regarding inventory checks and cycle counting, demonstrations were made in 2016 at a dry goods distribution center when a drone taking 30 images per second, reproducing a workers' path using a forklift to inspect labels and inventory; according to Shekar Natarajan, Walmart's vice president of last mile and emerging science, drones can reduce the cataloging process from one month to a single day (Blanchard, 2016). The technology is said to be six to nine months to be implemented, which means later in 2017 autonomous drone technology could reduce cycle counting times drastically when implemented across the 190 US distribution centers (Blanchard, 2016).

For in-store deliveries, Walmart's main goal is to "free customers from having to walk across its super-sized emporiums to find what they want"; to do so, it plans to develop a drone delivery system which would have an "automated air traffic control for dispatching drones and deciding

their flight paths" and each drone would have a sensor to avoid collision (Vanian, 2017). Delivering goods within the facilities' premises – as opposed to home delivery – highly distinguishes Walmart from other retailers, as it could bypass several regulations and technological limitations (e.g., equipment battery life and high costs for larger drones) (Vanian, 2017).

Blockchain for Food Tracking

Blockchain is essentially a "bookkeeping method that 'chains' together entries so that they are very difficult to modify later" (Popper and Lohr, 2017). According to IBM Technology Team's Shanker Ramamurty (2016), "blockchain provides a permanent record of transactions which are then grouped in blocks that cannot be altered". For that reason, Ramamurty considers that it could substitute traditional paper tracking and manual inspection systems, avoiding vulnerability in supply chains caused by data inaccuracies. Since supply chain tracking usually involves multiple practices from legal, regulatory to financial and commercial, the usage of blockchain could be beneficial because it allows all parties to securely and transparently records sequence of transactions until the product reaches the end consumer (Exhibit 5).

Although blockchain can be used across several different industries, food tracking is where it has seen a great potential. Tracking food items' "origination details, batch numbers, factory and processing data, expiration dates, storage temperatures and shipping detail" (Ramamurty, 2016) would mean easily identifying and addressing the source of food contamination, while also allowing managers to better manage shelf-life of products in stores (Slocum and Lui, 2016).

In October 2016, Walmart opened the Walmart Food Safety Collaboration in Beijing as it signed a collaboration agreement with IBM and Tsinghua University for the implementation of blockchain for its food tracking in supply chain. It has started its trials with two different

products: a packaged produce item in the U.S. and pork in China (Kharif, 2016). Using blockchain provides Walmart with two main advantages: transactions are recoded more securely, as they are more difficult to reverse/change than traditional ledger and it also let retailers to hold more data, allowing more detailed analysis; as a result, food can be delivered in stores faster and reducing spoilage and waste (Kharif, 2016).

Real-time Big Data Café

Walmart gathers 250 million customers' visits every week, who provide the company with 2,5 petabytes of data every hour. In order to analyze all this data, in 2014, Walmart set up what it calls a Data Café ("Collaborative Analytics Facilities for Enterprise"), an analytics hub in its Arkansas headquarters (Marr, 2017), as seen on Exhibit 6. According to SAP's managing partner for Walmart, Michael Diehr (2015), the retailer previously had a data warehouse which did not provide them with prompt answers to queries (daily and weekly reports were provided, but no information regarding market conditions in real time) and no information was provided for individual stores and SKUs (only product category).

This new Data Café needed to follow some requirements from Walmart, amongst are: hourly data updates instead of daily and a responsive system which allows managers to obtain information promptly – all queries should take eight seconds maximum to be completed (Diehr, 2015). It also uses transactional data from 200 sources, such as meteorological, economic, telecom, local events and etc. (Marr, 2017), which allows Walmart to identify causes and find quick solutions for underperforming items/stores.

Real-time data analytics also let Walmart adapt its pricing strategy to different stores across the U.S.: depending on buying behaviors and sales performance of East coast stores, the company can adjust prices for West coast stores before they open (Diehr, 2015). The Data Café can also

be used for inventory and stocking mismanagement: in 2016, after receiving information about an underperformed item in two stores, Walmart's sales analysts investigated the cause and identified that the product had not been put on the shelves, quickly fixing the error and preventing lost sales (Marr, 2017).

CPFR – Collaborative Planning, Forecasting and Replenishment; "My Productivity" App and SPARC (Supplier Portal Allowing Retail Coverage)

Concerning the forecasting process, Walmart was one of the first companies to shift from suppliers and buyers independent demand forecasts to a customer-focused forecast. The organization (alongside with IBM, SAP and Manugistics) developed in the mid-1990s a software package to calculate expected demand and exchange information to avoid different forecasts: as a result, in its pilot testing with Listerine, Walmart experienced a reduction in stock outs from 15 to 2 percent (Krajewski et al., 2015). Currently, it uses two solutions to assist its CPFR model: My Productivity app and SPARC (Supplier Portal Allowing Retail Coverage).

In 2016, Walmart launched its My Productivity mobile app, a software available for every member of the in-store management team, which essentially lets its users to keep track of sales, replenishment and warehouse data on the sales floor – prior to the app, management associates had to leave the sales floor and spend hours in the back room to perform those tasks (Ibbotson, 2016). My Productivity app can then be used to request restocking of items and check sales performance while employees assist customers in stores' aisles (Graham, 2016).

In the same year, Walmart updated its SPARC app launched in 2013. Within this application, suppliers gain access to inventory information, including which of their products are on the shelves and how they are performing with real-time information. This let suppliers and third party service groups to improve on-shelf availability of products without having to directly

locate store associates (CSA, 2013). Considering vendors and third party merchandisers visit Walmart stores to check their items, the app can reduce the labor force to serve those suppliers while allowing them to increase efficiency by spotting problems sooner and taking actions to avoid stock outs. The company started its pilot project with strategic suppliers in 28 stores and four different markets, such as L'Oréal, P&G, Kellogg and Unilever, but now made the tool available for smaller and mid-sized suppliers. The app layouts for both MyProductivity and SPARC are shown on Exhibits 7a and 7b.

Technological Innovation Applied to Tesco's Supply Chain

The UK retail giant Tesco was founded in 1919, and since then it has implemented numerous technological improvements to its SC strategy to fulfill its core purpose: "Serving Britain's shoppers a little better every day" (Tesco, n.d.). Considering the company reached 79 million shopping trips every week in 2015, even the smallest increments in SCM can represent meaningful differences in yearly results.

RFspot Pro Robots

Tesco's efforts in implementing RFID in supply chain started in 2004, a little after Walmart's initiative – the initial plan was to expand the technology to all of Tesco stores by 2006. Suppliers' noncompliance – as seen on Walmart's failed mandate – amongst with tougher EU regulations and standards limiting the use of technology made Tesco revise its RFID plans (Collins 2004/2006). Another RFID plan of larger dimensions would only be seen again in 2013 and after the implementation of the technology in Tesco's clothing line, which according to the company has "reduced out of stock levels by 95% and shortened the average time it takes for

staff to check stock by 7%" (Bowden, 2016). F&F is the apparel division of UK Tesco stores and it was the target for combining two revolutionary technologies: robotics and RFID. The clothing line is sold at more than 500 Tesco stores in the UK and the merchandise is completely RFID tagged.

In 2015, Tesco started its pilot testing for six-feet tall robots, known as RFspot Pro at five stores across (Exhibit 8). The robots travel across store aisles and stock rooms reading the RFID tagged merchandise. According to SC Digest, the RFspot pro robot, which is equipped with three sets of wheels, is able to move at a speed of one meter per second and to read RFID tags from up to 9 meters distances. The robot roams the store floor and also backroom in order to gather items' location data.

Prior to the technology, sales associates would use either handheld devices or reader portals. Such task could take up to 7 hours to be performed by Tesco's staff, while the robot is able to complete stock counting in only one hour, a fraction of the time of staff members. This allows Tesco to reduce labor costs: although the robots seldom require an operator, the human interaction needed is limited. Besides reading the tags and helping to locate products, the technology will also allow managers to identify misplaced items, restocking and replenishment needs and data regarding products that are performing better in terms of sales (Swedberg, 2015).

Finally, F&F Tesco's former CEO, Richard Collins, admitted the trials – besides serving to enhance customer experience – would also help identifying other areas within the rest of the store where the technology could be implemented, leaving room for further development in other product categories (Swedberg, 2015).

Augmented Reality Mobile App

In 2014, Tesco announced a collaboration to integrate IBM's Augmented Reality Shopping Advisor mobile app into its stores. The app can be used either in a smartphone or tablet and Tesco employees are required to photograph store's aisles, including quantity and location of products. IBM's app then "connects to Tesco's product database to analyze and identify the images. It compares the current display with the planned arrangement and instantly superimposes information that reveals insufficient quantities, missing products or misplaced items" (IBM, 2014). Since the app measures planned positions, planned quantity of products facing the customer, it allows employees to identify the type of incompliance with the planned arrangement, which goes from missing product, missing facings to extra facings and misplaced products, as shown on Exhibit 9.

Previously, employees were required to compare all products on shelves against a physical plan. With the usage of image recognition and processing and the comparison with the database to identify incompliances, Tesco increases replenishment speed, in stock item levels and overall the number of sales.

Inform App

Following the same footsteps of its competitor Walmart, Tesco began working on project Inform since 2014. Already having offered their customers numerous different grocery apps at the time, the retailer decided to develop their first "colleague" app named Inform, meant for store managers in the UK. The mobile application rolled-out to stores in 2016 (App Layout shown on Exhibit 10). Its main features are to "download, login and keep a real-time record of stock levels and availability" by scanning barcodes or side-shelf labels. The app then provides real-time data on products, which, alike Walmart's My Productivity software, increases speed

of replenishment and reduces out of stock merchandise. It also allows store employees to assist customers in aisles, instead of working in the back office to check for specific items manually. Inform app is part of Tesco's BYOD (Bring Your Own Device) strategy, which allows employees to use their own personal iOS, Android or Windows Phone smartphone to run the application. This is said to increase adoption levels when new technology is implemented in the store's environment, as it is considered to fill the gap existed between corporate and customer usage (Sillitoe, 2016).

It's Fresh & Buy One Keep One Packaging

Tesco has been an advocate for food waste for quite some time. It was the first UK retailer to disclose its food waste data to the public, including not only the total amount of wasted food, but also how it was divided by category (produce, meat, bakery, etc.), as shown on Exhibits 11a and 11b. In 2012, Tesco started to collaborate with the company It's Fresh for the implementation of new technology in packaging for fruits and vegetables (Exhibits 12a and 12b). The new packaging system has an "ethylene-absorbing strip, which sits inside the packaging, measures just 8cm by 4.5cm and will not affect its recyclability" (Tesco, 2012). Ethylene is the gas given off as fruit ripens, and the strip is developed to absorb it before the fruit does.

According to It's Fresh Ltd, it is "100 times more effective than any similar existing materials" and the benefits of the new package extends across the entire supply chain: for growers/suppliers, it increases consistency on the product delivered and reduces rejection rates; for retailers, it extends products shelf-life, reduces in-store waste and increases on-shelf availability, which ultimately leads to sales increase. In fact, after trials started, Tesco estimated the new packaging system would potentially save 1.6 million packs of tomatoes and 350,000 packs of avocados from going to waste (Tesco, 2012).

In the following years, Tesco continued to update its packaging for food products aiming to reduce further waste. In 2016, in partnership with Cargill poultry supplier and Linpac packaging supplier, Tesco UK introduced new chicken fillet packaging with two separate compartments, named “buy one keep one”, as seen on Exhibit 13 (Simister, 2016). And more recently, in 2017, the retailer introduced new packaging for mushrooms, as seen on Exhibit 14. Tesco switched from plastic punnets, which often formed condensation and deteriorated the product, to a fully recyclable material that allows moisture to be absorbed ; as a result, the company expects to extend product shelf-life and reduce waste (Cantoni, 2017).

Besides technological investment in packaging, Tesco also tackled its food supply chain, by removing a food packaging stage. In 2015, Tesco reduced one step in its supply chain, allowing products such as oranges, lettuce and tomatoes to stay on shelves for two days longer. Technical advances in packing and storing allowed certain items to be shipped directly from European suppliers to stores, reducing in transit time (Smithers, 2015). Reducing food waste is not only a moral and environmental concern for the company. According to data provided by the retailer, from 2016 to 2017, Tesco had more than 71 thousand tons of surplus – food that was not sold to customers – which ultimately accounts for sales losses.

Comparison

Having analyzed technological innovation implemented in retail supply chain, and focusing on two major players – Walmart and Tesco – it is imperative to break down differences in strategies, context of SCM decisions and market. First, it is important to note that the two companies operate globally. Considering the aforementioned information, Walmart operates 11.695 stores worldwide as of 2017, while Tesco’s added up to 6.809 stores across the globe according to its latest data from 2016. However, Tesco implements and pilot test its technology

only locally, in the UK, while Walmart clearly focuses on a global approach (e.g. Walmart's pilot testing for food tracking using blockchain, which happened simultaneously in the US and China, involving multiple suppliers in both countries). This strategy of global vs. local approach is clear in two aspects of managerial decision making. Firstly, Walmart group operates in three different segments: Walmart US, Walmart International and Sam's Club. That means all its international operations in 27 countries is combined in one homogenous segment. Not only that, it also developed an enterprise-wide strategy, of leading on price, investing to differentiate on access, being competitive on assortment and delivering a great experience for all of its segments. This combined strategy of a global operation's segment allows Walmart to apply technological innovation across its stores in a frictionless way (Walmart, n.d.).

Tesco, in turn, separates its operation segments by each country. Although it is fair to assume it would be reasonable, considering they operate in less countries (9 as opposed to Walmart's 27), the biggest constraint is that the company adopts significantly different strategies and even objectives in each of those segments. Tesco UK's pledge on eliminating food waste, for instance, is applied only locally. That means supply chain innovation found in the It's Fresh and "buy one keep one" packaging would rarely be applied elsewhere in the short-term. This local vs. global approach can also be seen in the companies' labs for technological development, named Walmart Labs and Tesco Labs. While Walmart built its labs in three different locations – Brazil, US and China – Tesco has only one office located in their home market, UK.

Those labs are where both retailers test and develop the latest technology and it is essential to consider market conditions and the financial wealth of both organizations when assessing the investment opportunities for both labs. Tesco recently experienced the biggest loss in history for a UK retailer: in 2015, the company reported a pre-tax loss of £6.4 billion, after announcing in the previous year it had overstated its profits by £263 million and facing accounting fraud

investigation (Chambers and Ring, 2017). This clearly reflects on expenditure for technological development: the company reportedly invested only six figures in its lab (Chapman, 2016), what Tesco Labs itself calls a "very modest budget". Walmart, on the other hand, has seen stability in its financial performance over the course of the past years, as seen on Exhibits 15a and 15b and remains the largest retailer in the world. The result of this discrepancy is clear if one observes the retailers' labs structure: Walmart Labs was founded in 2011 after the company acquired Kosmix – founded in 2005 – for reportedly US$300 million and already employs over 3,500 employees in three different countries (Walmartlabs, n.d. & Gobry, 2011). Tesco Labs' is present only in the UK and counts with roughly 30 employees. With financial instability and smaller investments in technological improvement, it is possible to observe only small incremental changes in Tesco's supply chain, generally in-store improvements, as opposed to Walmart's larger scale investments, as its Big Data Café analytics hub.

Finally, there are certain conditions outside the companies' decision making scope which also arise: different technological innovation often deal with different regulatory aspects. Big data, for instance, is subject to numerous regulations regarding privacy concerns. Deloitte's 2015 report on Big Data shows that the number of privacy laws increase from 20 to over 100 from the 1990s to today. According to the report, however, there are big differences in data privacy law maturity: the European Union member states have a comprehensive privacy law, which means European guidelines tend to limit the usage and protect data in a broader number of areas; while the US, on the other hand, is generally considered less restrict in that matter, having data privacy regulations only in certain areas, such as medical records and financial information. Although it is unsure if this deregulation can sustain in the long-term, it still would justify a higher investment in Big Data analytics for companies operating in the country.

Below, a table comparing the technologies addressed formerly and their respective impact in each of the retailers' supply chain, and the results considering corporate strategy objectives.

Technology	TESCO	Impact and Results for Tesco	Walmart	Impact and Results for Walmart
RFID	**Yes**	**◘**	**Yes**	**◘**
Drone	**No**	**---**	**Yes**	**○**
Blockchain	**No**	**---**	**Yes**	**◘**
Real-Time Big Data Café	**No**	**---**	**Yes**	**●**
Mobile Applications	**Yes**	**◘**	**Yes**	**●**
Augmented Reality	**Yes**	**◘**	**No**	**---**
It's Fresh & Buy One Keep One Packaging	**Yes**	**◘**	**No**	**---**

● - Very High Impact; ◘ - High Impact; ◘ - Minor Impact; ○ - No Impact

5. Conclusion

Having analyzed some of the most common technological innovations applied to retail supply chains, identifying specific applications in two of the biggest worldwide retailers and finally comparing the circumstances of those differences, it is possible to gather answers to the proposed research questions.

Q1: How is current technology being applied and in which ways it has improved supply chain performance for Walmart and Tesco?

RFID has been used by Walmart in apparel to inventory back room or racks, which can reduce the task from one day to one hour. The usage of RFID to position inventory saved the company US$290 million. Tesco, in turn, uses the Rfspot Pro robot to read tagged clothing items instead of handheld reading devices, which identifies misplaced items, restocking and replenishment needs at up to nine times faster than conventional methods. **Drones**, although still in testing phase by Walmart, are expected to reduce labor force costs by reducing cataloguing process time from one month to a day, while drone in-store deliveries can increase replenishment speeds. **Blockchain** is mainly used to increase food safety by identifying the origin of food contaminations, but also can allow more accurate shelf-life management, with precise and easily accessible data regarding the product's origin. **Real-Time Big Data** hub provides information regarding underperforming goods for identifying stocking mismanagement and slow replenishments. **Mobile apps** in Walmart are used by both employees (My Productivity app: easily accessible replenishment and warehouse data results in less back room visits) and suppliers (SPARC: providing real time information regarding product performance can reduce stock outs). Tesco's Inform App offers roughly the same features as Walmart's, but does not provide a solution for suppliers. **Augmented Reality** is used by Tesco to quickly identify incompliances with planned items positioning by comparing to database, which also increases replenishment speed and reduces stock outs. Finally, through **Packaging Innovation** Tesco's suppliers can increase consistency and lower rejection rates and Tesco can reduce in-store waste and on-shelf availability of fresh products.

Q2: How do Walmart and Tesco achieve technological improvements in their supply chain?

Both companies are retailers at its origins and therefore primarily do not possess the technological know-how to individually develop hardware and software solutions for supply chain optimizations. Therefore, Walmart and Tesco use fundamentally the same approach, by

establishing partnerships and collaborative agreements either with tech companies, suppliers or a combination of both. Walmart's RFID strategy began with partnership with eight suppliers, amongst are Gillette, HP, Johnson & Johnson, and Procter & Gamble. Blockchain technology is the result of a collaboration between Walmart, IBM and Tsinghua University. For Big Data, SAP was responsible to deliver a tailored solution for analytics, following Walmart's strict demands. Tesco, in turn, had its RFID robot developed by RFspot; augmented reality mobile app by IBM and the new packaging through either It's Fresh or Linpac. Recently, however, one can notice a change in the retailers' strategy. Although both still use the aforementioned strategies, it is visible that Tesco and Walmart are trying to switch this process, at least partially, to in-house development through its labs. Walmart Labs was founded in 2011, after the acquisition of Kosmix, and already acquired fifteen tech start-ups since then, growing to three different countries. Tesco is adopting the same strategy, but at a slower rate, with the implementation of Tesco Labs in 2014.

Q3: In which ways technological improvements in Walmart and Tesco's supply chain differentiate and why?

Walmart is working towards more disruptive technology, which are utilized across many different supply chain stages (Blockchain, for instance, registering all the steps from the supplier to the end consumer; Drones in warehousing and in-store delivery, etc.). The company is also committed to making higher investments (e.g., Walmart Labs division, reportedly acquired for US$300 million; creation of specialized analytics hub), which essentially involve higher risks. Tesco, in turn, generally achieves smaller increments, which are mainly in-store improvements (e.g. RFspot pro robot, augmented reality and Inform app), intrinsically involving lower investment and less risks. This happens mainly considering differences in global and local strategies (Walmart adopting one common international segment for all abroad

operations and Tesco focusing exclusively on UK operations), different market regulations (e.g. privacy concerns, drone requirements and regulations) and difference in financial health and profits.

Debate

Throughout this paper, one can acknowledge that technological development assists companies to streamline their supply chain, as seen with all the practical benefits of technology implementation in daily operations. However, with the constant growth/improvements seen in competition – especially with the development of omnichannel retailing and the increase in ecommerce demand – this technological "assistance" becomes a necessity if a retailer aims to stay relevant.

To tackle this new mindset, retailing managers are required to shift their focus from exclusively core retailing practices to also technological innovation. In this scenario, investment in high standard labs as well as specialized start up acquisitions can help retailers in such transition. This is where financial health of the organization can make a big difference in their outcome: higher investments support further research, not only for the development of new technology that may arise, but also for understanding new applications and different uses for the current ones.

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