Innovation Work Chains in US Retail: Automation, Tracking and AI Adoption during the COVID-19 pandemic

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Abstract

The 2020 global pandemic led to record grocery sales and significantly accelerated the adoption of online retail services. This trend is expected to grow as mainstream retailers aim to keep up with the speed of delivery from ‘digitally native’ competitors and changing consumer expectations.

Technological innovation is being introduced to different parts of the retail supply chain leading to a changing landscape for jobs. Here we develop the concept of Innovation Work Chains (IWC). We use this framing to discuss how the introduction of different types of innovative technology are likely to impact on employment practices across the supply chain in large-scale grocery retail. This research draws on sector reports and extensive interviews with Walmart US and one of their technology partner organisations in the USA.

The focus is on how automation technologies like robots, tracking technologies and AI have become pivotal to the efficient management of retail supply chains. The evidence suggests that an iterative process of adoption and adaption is required to develop company specific solutions. However, legacy systems can pose a challenge to the speed at which automation technologies can be efficiently integrated. The concept of Innovation Work Changes highlights the differential impact on the employment landscape across the retail eco-system.

Key words:
Artificial intelligence, automation, employment, diffusion of innovation, technology drivers, retail, robots, supply chain, tracking technologies, Walmart US
Key Points

1. The pandemic resulted in online grocery sales accelerating significantly. Before the pandemic they accounted for less than 2% of all grocery sales. Predictions suggest up to 10% of grocery sales will be done online after the pandemic, with this being concentrated on major US retailers. Others are forecasting online grocery sales will grow to 21.5% of all US grocery sales by 2025 – an 8% increase on pre-pandemic estimates.

2. Walmart had a 79% growth in online sales during 2020. While Walmart has been hailed as a flagship for technological innovation and early adoption in the retail sector, it is still relatively early in its digital transformation journey from bricks-and-mortar retailer to fully online digital supply chain operation.

3. Omnichannel operations add complexity and cost to supply chain management. To respond to this, Walmart is significantly accelerating technological innovation efforts. It is adopting automation technologies in advanced robotics, tracking and labelling, and artificial intelligence (AI) across its supply chains. The aim is to improve customer experience and operational efficiency.

4. Complexity and cost impact the likelihood of technology adoption and diffusion. Successful and scalable automation requires the right investment strategy, cross-functional governance and core capabilities from inside and outside the business. Businesses may need to be prepared to enter markets ahead of customer demand to gain competitive advantage.

5. The transformation from an established manual supply chain operation to a highly autonomous one risks interrupting business-as-usual operations. Legacy systems can pose a challenge to the speed at which automation technologies can be adopted. An iterative process of adoption and adaption is required to develop company specific solutions that can address business challenges.

6. The full impact of automation on retail workers is yet to unfold. Labour-saving technologies will change operating models. Technologies that replace skills are more likely to face obstruction. Enabling technologies that remove tedious or arduous tasks and enable better quality jobs are more likely to be welcomed. Changing labour models will need to be actively managed to ensure the right mix of recruiting new talent, advancing training and supporting transitions for those at risk of job displacement.

7. The concept of Innovation Work Chains highlights the differential effects of these technologies on employment at specific points along the supply chain for different groups of workers.
Abbreviations

AI    Artificial Intelligence
ASR   Automatic Storage and Retrieval
BRC   British Retail Consortium
CSAT  Customer Satisfaction
DoI   Diffusion of Innovations
GPS   Global Positioning System
GS1   Global Standards body for barcodes and RFID
HPO   Hours Per Order
IoT   Internet of Things
IWC   Innovation Work Chains
MFC   Micro-Fulfilment Centre
NPS   Net Promoter Score
RFID  Radio Frequency Identification
SKU   Stock Keeping Unit
TMS   Transportation Management System
UPLH  Units Per Labour Hour
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1. Introduction

Grocery retail sales hit record highs during the 2020 global COVID-19 pandemic and accelerated the adoption of online shopping and home delivery services (Mintel, 2020; Balchandani et al., 2020; Gerckens et al., 2021; Beek et al. 2021; Rolf et al. 2022). This is likely to be a lasting change for many consumers in the post-COVID era.

In the US, online grocery sales accounted for less than 2% of all grocery sales before the pandemic but it is estimated that up to 10% of grocery sales will be done online after the pandemic (Benner et al., 2020). Many older shoppers are likely to return to in-store shopping, but the increased familiarity, convenience and choice will lead to many consumers continuing to shop online. By 2025, online grocery sales have been forecast to grow to 21.5% of total US grocery sales – an 8% increase on pre-pandemic estimates (Mercātus and Incisiv, 2020).

This trend creates major challenges for traditional bricks-and-mortar retailers. Omnichannel operations add more complexity and cost. They create challenges for product availability, inventory visibility and fulfillment options for customers. For instance, last-mile delivery is more expensive and logistically complex than in-store fulfillment.

The growth of eGrocery has accelerated technology investments by retailers to meet demand, lower costs and keep up with digitally native competitors like Amazon and other online-first retailers. In this context the implementation of automation technologies like robots, tracking technologies and AI have become pivotal to improving the customer experience, efficiently integrating online and offline and in managing the retail supply chain.

The implications for employment because of this adoption has tended to polarise either around potential job losses or arguments that it will lead to improvement in job quality. These debates have focused on particular types of jobs, for example, those of cashiers being replaced by self-service tills. However, this is only a small part of the face of retail employment. The aim of this paper is to provide a more holistic account of how these changes are impacting across the supply chain by developing the concept of Innovation Work Chains (IWC). This concept aims to identify how different types of digital technologies are being deployed at points along these supply chains, and to provide an initial analysis of how this is both creating and reshaping the job landscape in retail.

The research draws on sector reports and original empirical research with senior supply chain leaders at Walmart US and one US partner organisation to outline the ongoing technological transformation projects and challenges presented by the pandemic to the retail sector. We briefly review the key trends identified in the literature on the adoption of disruptive automation technologies into retail supply chains and their impact on employment, outlining the analytical focus on Innovation Work Chains in section 2. Section 3 provides an overview of the business opportunities and challenges Walmart US is facing. The methodological approach used in this study is outlined in Section 4, and the analysis and discussion of our empirical findings are reported in Section 5. In conclusion we highlight the complex and iterative nature of
technological transformation of retail supply chain operations built on highly manual business process. The simultaneous rapid and slow changing labour models across these innovation work chains requires complex understanding both of technological change and new forms and patterns of HR management to ensure the right mix of new talent, training and support for these digital transformations that will both create new types of jobs as well as restructure traditional employment.

2. Technology and Innovation Work Chains in Retail

Rapid adoption of advances in digital technologies opens up new opportunities for retailers to improve the quality of services and to deliver operational efficiencies. But the deployment of automation technologies alone does not always guarantee success (McKinsey Digital, 2019). In its 2018 automation survey, McKinsey found that over half of the 1,300 companies surveyed had leveraged automation technologies; however, only 55% said their automation programme had been a success. Here, we outline some of the emerging technologies being used in retail supply chains around advanced robotics, tracking and labelling, and artificial intelligence (AI). We identify the key business drivers affecting adoption and diffusion and how these decisions will impact the future of innovation work chains.

2.1 Emerging supply chain technologies in retail

Supply chain management is experiencing significant disruption to previously manual business operations because of fourth industrial revolution technologies and hyper-automation (Alicke, Rexhausen and Seyfert, 2017; Burke, 2020; Manners-Bell and Lyon, 2019; Schwab, 2016). Warehouse automation, in particular, is predicted to lead the way in industry-wide adoption over the next five years (Manners-Bell and Lyon, 2019). We look at how retail supply chains are being impacted by three key technologies: robotic automation, tracking technologies and AI.

**Robotic automation** is touching all parts of the supply chain – from automated warehouses picking and transporting goods to drones providing last-mile delivery and returns (Alicke, Rexhausen and Seyfert, 2017). Robots are forecast to completely transform warehouses by the mid-2020s. Autonomous movement of crates and pallets, and advances in automated arms to grasp and manipulate individual items will lead to automating complex order picking operations. Advancements like Dactyl, a five-fingered robotic hand developed at Elon Musk’s OpenAI lab in San Francisco (Open AI, 2018), is a step closer to having technology with human-level capabilities that can, for example, manage the mostly manual process of order picking.

**Tracking technologies** – commonly referred to as the ‘Internet of Things’ (IoT) – are enabling better communication and autonomous coordination between people and the ‘things’ being stored or transported between supply chain producers, vendors, warehouses, transportation companies, distribution centres and shops (Ben-Daya, Hassini and Bahroun, 2017). A rich mix of technologies, including Radio Frequency
Identification (RFID), GPS devices, sensors, smart phones, social networks, cloud computing and data analytics, enable greater visibility down to an item level.

The adoption of product tracking technologies is driving greater efficiency, transparency and agility across retail supply chains. ‘Digital shelving’ tracking technologies identify when stock is running low on the shelves, in the stockroom and in distribution centres enabling products to be routed to where there is highest demand (Manners-Bell and Lyon, 2019). Tracking in containers monitors product location and environmental conditions, for example the storage temperature. These can optimise inventory by enabling retailers to identify and replenish out-of-stock items more easily, which is becoming increasingly important as retailers race to integrate in-store and online customer experiences.

AI plays a significant role in automation and tracking technologies, generating huge amounts of real-time data, metrics and information and enabling machines to perform tasks and make decisions without any human interaction. In the grocery supply chain algorithms are being experimented with in Warehouse Management Systems to optimise the picking routes and product placement, in robotics, and in autonomous self-driving vehicles or drones (Manners-Bell and Lyon, 2019). It is being managed through control towers – cross-functional teams using real-time data and analytics to speed up business decisions – to help make sense of and act on this data (Kuntze, Lal and Seibert, 2020; Manners-Bell and Lyon, 2019). Retailers are also using AI to enable better workforce analytics on employee engagement and productivity (Zebra Technologies, 2020); although concerns have been raised around the extent of surveillance and control (Ponce Del Castillo, 2021).

Using this data effectively is not only an organisational and technological challenge but is at the heart of recruiting the right people across the Innovation Work Chain. According to Abdulrahman et al. (2017: 1) ‘developing robust ways of handling and cleaning qualitative social media data as well as getting well-trained and highly skilled human resources in all aspects of big data analysis and interpretation remains a major challenge.’ Many organisations are facing the double challenge of integrating the right technology and having the right people in place to use it effectively and ethically (Angrave et al., 2016; Chan et al. 2017).

### 2.2 Technology adoption and diffusion

There exists an extensive body of research on effective models of technology adoption and diffusion (Lai, 2017; Taherdoost, 2018). Here we focus on the Diffusion of Innovation approach that distinguishes between five adopter categories: innovators, early adopters, early majority, late majority and laggards (Rogers, 2003). Entering emerging markets ahead of demand – or being the early adopters of new technologies – can provide first-to-market advantages for companies according to Christensen (2016).

A company’s capabilities are critical to supporting this. Alongside the capabilities in people, Christensen (2016) has argued that organisational capabilities (e.g., company values) can both be enabling and disabling because they form the basis on which investment priorities are set. So, for example, if driving low cost is the basis of company values then the cost of short-term investment could limit appetite to
substantial transformation. He cautioned against always being customer-led because if technologies are only invested in when customer behaviour changes it can often be too late to ensure a strong foothold in the market.

Factors influencing the rate and degree of adoption across the adopter types include: relative advantage, compatibility, complexity, trialability and observability (Rogers, 2003). See Figure 1 for definitions.

**Figure 1 Factors influencing technology adoption (Rogers, 2003)**

Relative advantage and complexity have been argued as being particularly key in determining the speed or likelihood of technology adoption (Tsai, Lee and Wu, 2010). To address complexity, large incumbent technology companies and small start-ups both have an important role to play in enabling technological innovation in retail supply chains. However, while large established companies may have better ability to leverage their resources, it is often the case that smaller companies are more able to take risks and be agile in fit-for-purpose technological development (Manners-Bell and Lyon, 2019).

**Intrafirm diffusion** – the intensity of deployment of a technology within a company – has also been used as an indicator of the value of technology adoption and its productivity effects (Fuentelsaz, Gómez and Palomas, 2009). These are particularly pertinent concepts to help us understand the deployment of digital technologies across complex retail supply chains. Technology developed and adopted in one part of the
business (e.g., the warehouse) will have knock on implications further down the innovation work chain (e.g., the shop floor).

McKinsey has carried out extensive analysis of the future of AI and automation (McKinsey Digital, 2019). Central to the successful and scalable deployment of digital technologies is a strategy that emphasises: a systematic rollout, decentralises governance, provides clear costs and benefits, involves IT and prioritises workforce management. In its analysis for the retail sector, McKinsey proposes six essential steps to support retailers in managing a successful programme of automation (Balchandani et al., 2020). These include:

1. **Master plan** – cross-functional teams to steer and manage the transformation programme with defined customer, financial and employee satisfaction KPIs to gauge and measure success throughout rollout.
2. **Consumer value proposition** – a clear ambition for how technology deployment will impact the customer experience (e.g., convenience, cost, speed). This may vary by region and customer demographic.
3. **Operating model** – a rethink of how labour and technology can support the delivery of the service level ambitions set out in the customer value proposition, and the iterative steps that need to be taken to achieve the end goals.
4. **Technology** – processes for supporting the sourcing and selection of fit-for-purpose technologies. Including the identification of external vendors to develop and maintain new technologies, and systems for testing and iterating.
5. **People** – active engagement on and management of changing labour models and supporting talent management plans. This will involve a mix of skills training for existing staff and identification of new job roles that will need to be hired.
6. **Community impact** – strategies for supporting workers and communities that are more impacted. Plans for how to support displaced workers. Regional rollout plans designed to minimise negative impact on communities.

In summary, technology adoption can be costly and complex. An overarching strategy and plan, a company-wide cost-benefit analysis and a company’s capabilities – people and organisational – are key factors contributing to successful technological adoption. Customer centricity is important but the early adoption of new technologies ahead of customer demand can provide competitive advantage. Having a clear ambition for how the deployment of technology will benefit the future customer rather than deploying technology innovations once customers’ behaviours change can lead to a stronger foothold in the market. We cover the impact on people and employment in more detail in the next section where we discuss the concept of Innovation Work Chains.

### 2.3 Innovation Work Chains

There is significant debate about the extent to which jobs will be impacted by technological change (Frey 2019). Widely reported research using AI to analyse 702 occupations covering 97% of the US workforce, estimated that 47% of US employment is at high risk of automation (Frey and Osborne, 2017). Others have suggested forecasts like these are an overestimation and have presented more modest predictions based on the analysis of job tasks that show 9% of US jobs are at risk of automation (Arntz, Gregory and Zierahn, 2017).
More recently, research from the OECD estimates 14% of jobs are at high risk of being replaced and 32% risk significant transformation (OECD, 2019). McKinsey Global Institute has predicted around a third of retail tasks will be displaced by technology by 2030 – with the biggest impact being felt by cashiers and check-out operators, sales and retail assistants and supply chain warehouse roles (Balchandani et al., 2020).

Here we propose a more holistic perspective we call an Innovative Work Chain model (Figure 2). This allows us to examine how technological interventions are being introduced across the retail supply chain and to understand how the job landscape is changing in terms of the types of jobs that may be disappearing or emerging both within organisations and their technology partners. This working paper is a first step in exploring the concept of Innovation Work Chains and is being developed further in subsequent research (Hunt and O’Reilly 2022).

Figure 2 Conceptual framework for the Innovation Work Chain

An Innovation Work Chain (IWC) captures an eco-system of organisations that contribute to innovative technologies in this case retail supply chains. The novelty of this approach is that it goes beyond established supply and global value chains research by emphasising the employment effect of these changes at different points in the chain. The contributory organisations to this innovation work chain are outlined in Figure 2. Technological innovations can start in the lab with research and development. These prototypes are then developed and commercialised by companies who progress and scale up these inventions so they can be manufactured for a larger market. End users include organisations who decide to implement these technologies in their own business processes affecting the way they organise work and deliver services in their companies, in the case discussed here, large scale retail. At each stage differing skill sets are required and will change as products are developed and deployed. The advantage of this approach encompasses a more
holistic understanding of where jobs are being created, disappearing or changing along these chains. To illustrate how this approach can be used to synthesise existing findings we summarise how these have been discussed to date.

In the grocery industry, some have concluded that technology adoption is leading to a growth in jobs – with the acceleration of online grocery ordering during the pandemic leading to the creation of new jobs to fulfil orders (picking, packing and delivering) and in more technical roles to enable customers to shop online (Benner et al., 2020). At the same time this development is a threat to cashier jobs, which were already in decline as a result of increasing use of customer self-checkout technologies. In the US, around half of all online orders are picked up by customers at the store after it has been prepared by retail workers. Home delivery is mostly fulfilled by platform-based workers (like Instacart in the US), but many large retailers are starting to develop their own home delivery systems.

The impact of labour-saving technological innovation can be thought of in terms of enabling or replacing technologies (Frey, 2019). For example, in retail Amazon has been opening grocery stores across the US and UK using a range of job replacing technologies (Amazon, 2021; Day, 2021). Its Amazon Go stores are using what it calls ‘just walk out’ technologies – including sensors, vision cameras and machine learning – to create the ultimate cashier-less checkout experience. Finnish brand Neste has opened fully automated grocery stores across Finland powered by RFID (Neste, 2020).

In the US, retail accounts for around 10% of all US employment – of this, 20% (or 3.2 million people) work in grocery retail (Benner et al., 2020). The grocery sector is dominated by the big four players Walmart, Kroger, Albertson and Ahold Delaize; all of which have an important impact on the industry as a whole. In 2019, cashiers accounted for nearly 30% of all jobs across the retail sector but estimates suggest this will significantly decline over the next decade.

Nevertheless, the pandemic led to the need for more grocery workers to pick and pack in order to fulfil orders. This is labour-intensive so some major retailers are opening micro-fulfilment centres (MFCs), which are relatively small, semi-automated systems for fulfilling orders. During the pandemic Walmart recruited over 450,000 workers across the US.

The speed at which technology will be adopted is likely to be impacted by the extent to which technology will augment and enable workplace productivity versus replacing jobs altogether. History, according to Frey (2019), has shown, in the long run, how job opportunities have increased as a result of technological innovation resulting in economic growth. Automation of repetitive tasks have the potential to free up time for workers to add value in different ways – for instance, in areas that are not easily automatable like customer service (Balchandani et al., 2020; Frey, 2019; Willcocks, 2020).

While some elements of automation will reduce routine manual tasks, it will also create jobs in new areas across the innovation work chain (Figure 2). For instance, the increased use of digital technologies will require data scientists, software developers, engineers and IT professionals to design, deploy and maintain data-enabled decision-
making systems; and higher-skilled labour will be required further down the innovation work chain for monitoring and managing high-tech warehouses, fulfilment centres and customer service points (Kuntze, Lal and Seibert, 2020; Rüßmann et al., 2015).

These changes will also bring about considerable skills displacement. According to the OECD (2019) as many as 6 in 10 adults lack the basic skills needed for the new jobs – for instance, they have no computer experience or ICT skills. Companies will need to rethink labour models as tasks and skill requirements change as a result of adopting these technologies. Companies will increasingly need to have the right education and training in place to equip workers with the skills necessary to fully harness the benefits of enabling – and to a lesser extent replacing – technologies (Manners-Bell and Lyon, 2019).

The full impact of automation on retail workers is yet to unfold but it is becoming increasingly apparent in the retail sector that three types of technologies – automation, tracking and AI – are having a very disruptive effect on both retail services and the people employed to deliver these services. The rest of this report focuses on how these trends are being addressed at a major US retailer.

3. Technology in Grocery Retail in Context: Walmart US

With $560 billion in global revenue, Walmart is the largest retail company in the world (Walmart, 2021). Its $35 billion growth in sales in 2020 makes it one of COVID-19’s retail winners. It has 2.3 million employees worldwide and 220 million customers visiting its 10,500 stores and eCommerce websites each week.

For Walmart, the pandemic was good news and bad news. Alongside its record year in sales, the pandemic also caused significant disruption to its usual business operations. Walmart saw a 79% growth in demand for its online services. It has long been championed as a retail technology leader, even before the pandemic. However, the scale and speed of disruption during the pandemic accelerated its digital transformation programme and lead to a massive increase in recruitment (Hunt and O’Reilly 2022).

Walmart has its biggest presence in the US with over 4,700 stores covering 90% of the population within a 10-mile radius. It has more than 150 distribution centres supporting 90 to 100 stores in a 150-mile radius. Its US operation earned it $370 billion in annual revenue in 2020, an 8.5% growth on the previous year. It has 1.6 million employees, making it the largest private employer in the US.

3.1 Walmart’s growth in eCommerce

The growth of eCommerce in the US has led to a rapidly shifting landscape for Walmart’s logistic and supply chain operations. Figure 3 is a simple illustration of evolving supply chain operations in retail. This has shifted from a relatively straightforward operation of moving products from suppliers, through distribution and
into stores and onto customers, into a complex operation that now serves a more diverse set of locations to deliver these goods to consumers through growing eCommerce channels.

To meet new demand for online services it has opened ‘dark’ store operations and micro-fulfilment centres (MFCs) to support the growing use of its pickup and home delivery services. Dark stores are highly automated mini warehouses that are organised and operate like a store but are closed to customers. MFCs leverage existing stores to increase online order fulfilment. Walmart is also considering working with select suppliers to deliver their merchandise direct to MFCs, which it says will improve efficiency.

Figure 1 An illustration of Walmart’s evolving supply chain

3.2 The pandemic as a catalyst for supply chain innovation

The COVID-19 pandemic accelerated the growth of Walmart US eCommerce sales by 79% in 2020 (Walmart, 2021). At the height of the pandemic, the number of new customers trying its pickup and delivery services increased fourfold. It saw a sales growth of nearly 300% at its peak in March 2020. The challenge of meeting this growth in demand for its eCommerce services has been a significant catalyst for technology innovation taking on a new urgency, with a specific focus on how it can use supply chain technologies to deliver services to customers more conveniently and faster. In February 2021, Walmart announced its intention to invest $14bn in 2021 to build additional supply chain capacity and automation to stay ahead of demand, improve customer experience and increase productivity (Walmart, 2021).

3.3 High employee turnover in retail

Labour is a critical factor when thinking about where technology can be deployed to scale up or scale down capacity as efficiently as possible. Employee turnover in retail services is high – in 2019 it stood at 58% in the US (U.S. Bureau of Labor Statistics,
2020). Like all retailers, retention is a challenge, particularly roles that are labour intensive or physically demanding like stacking and unpacking pallets. Alongside greater people investment initiatives (e.g., wage increases, job promotions and staff training), Walmart is looking at where software and technology can support or even replace job roles, especially those vulnerable to high turnover.

4. Research objectives and methodology

4.1 Objectives

The research aims were to contribute to the Digit Research centre’s objectives to:

1. Generate new knowledge to inform the development of an analytical framework around the concept of the ‘connected worker’ and the ‘connected economy’, which it achieved in the development of the concept of Innovative Work Chains.
2. Maximise knowledge exchange and co-produced research with relevant communities, which it achieved in collaboration with Walmart where we agreed to focus on three primary research questions:
   - What supply chain automation technologies is Walmart adopting, and why?
   - How are decisions made about what technologies to adopt?
   - What are the employment consequences of these decisions?

The focus of this study was designed in collaboration with senior Walmart HR and, Innovation and Supply Chain executives who acted as business sponsors throughout the project and fed back on the findings in this report.

4.2 Methodology

Planned on-site research visits to the US in the summer of 2020 were agree in February 2020 but had to be cancelled due to travel restrictions related to the COVID-19 pandemic. Walmart proposed us conducting this research remotely, so all interviews were conducted via zoom between the autumn of 2020 and spring 2021. In-depth semi-structured interviews were conducted with 11 senior supply chain leaders at Walmart and one with partner organisation Plug and Play (an organisation that connects technology start-ups with big corporations); additional secondary materials were derived from professional sector reports.

Interview participants were identified in collaboration with our executive business sponsors to include supply chain executives and leaders in fulfilment centres, software engineering, sustainability and technology partnerships. Our interviewees draw on a vast amount of experience – both in terms of tenure at Walmart (with some serving between 10 and 20 years) and experience of working for other major commercial players (e.g., Amazon, Google, Yahoo and UPS). Interviews lasted between 40 and
80 minutes (with most lasting about an hour). Digital recordings and transcriptions were generated for all interviews. In some cases, respondents were interviewed on more than one occasion.

### 4.3 Qualitative data analysis

Interview data was cleaned and analysed using NVivo and thematically coded. Analysis focused on what technologies Walmart has been adopting across its supply chain, the business drivers behind why these technologies are being adopted, how they identify and develop the right technologies, and how technology adoption impacts employment. *Figure 4* illustrates the top-level analytical framework against which the data was coded.

*Figure 2 Top level analytical framework*

The following discussion of findings is structured according to this analysis. We start by exploring the types of automation, tracking and AI technologies Walmart is adopting across its supply chain. We then explore the factors driving technology adoption (customer, cost, capacity, capability) and the way it makes decisions about technology adoption (identification, partnerships and metrics). Finally, we look at the how technology adoption is changing the shape of jobs.

### 5. Research findings

The significant growth in eCommerce for Walmart US means the merging of online and offline customer experiences need to take on a new urgency. Today, even with the growth of ecommerce the mode of supply chain operation is still predominantly based on associates (workers) doing the picking as if they are customers before
handing off shopping for delivery or pick-up. Walmart has been experimenting with and adopting a range of technologies and systems that bring together logistics, warehousing, purchasing and delivery to deliver cost efficiencies to the business and greater convenience to its customers.

5.1 Supply chain adoption of automation technologies

We have broadly grouped the supply chain technologies being adopted and experimented with into three clusters: automation and robots, tracking technology and artificial intelligence. Figure 5 illustrates examples of the supply chain technologies being implemented and experimented with across this chain from suppliers to end consumers. This complements the more holistic approach provided by the Innovation Work Chains model adopted in this analysis. It has the advantage of pinpointing specific technologies at particular points in the supply chain and linking this to differentiated HR requirements.¹

Figure 3 Examples of where Walmart is investing in the adoption of supply chain automation

By automation and robots, we are referring to robotic systems used across warehousing, fulfilment and delivery operations. Tracking technologies include labels, sensors and networks that enable supply chain visibility. Artificial intelligence refers to software that enables tasks to be performed without human intelligence.

5.1.1 Automation and robots

Walmart’s first high-tech distribution centre with fully integrated automatic storage and retrieval (ASR) systems opened in Shafter, California, in Autumn 2021. It deploys robots to autonomously move totes, cases and pallets around – getting them on and off trailers and stacking and delivering them. It also uses a host of other technologies e.g., wearable technology and vision cameras. It is estimated it will move 40% more products than traditional distribution centres. Autonomous yard trucks are also being used across distribution centres to enable the remote running of distribution yard operations – moving freight between over-the-road trucks and warehouses.

¹ A more focused assessment of store recruitment is developed in Hunt and O’Reilly (2022).
Online fulfilment: Walmart partnered with Alert Innovation to launch its robotic Alphabot autonomous carts to work with associates in its Salem MFC in early 2020. Walmart claims this ‘first-of-its-kind’ technology will ‘revolutionise the online grocery pickup and delivery process for associates and customers.’ The pickup and delivery process currently works by associates selecting, packing and delivering items directly from the shop floor. The Alphabot autonomous cart takes on part of this job by retrieving and delivering ambient, refrigerated and frozen food from with the warehouse. This drives significant time efficiencies, as one senior supply chain director said:

’Some of our stores are upwards of 200,000 square feet which is a huge distance for associates to travel back and forth to pick products.’

In-store fulfilment: Walmart has been experimenting with a series of robotic smart assistants – for example, its Fast Unloader robot scans and sorts inventory to get products onto shelves faster and its Auto-C robot handles routine cleaning tasks.

Last-mile delivery: autonomous transport for moving orders from fulfilment to delivery and pickup points is being piloted. Walmart is experimenting with contact-free delivery options via self-driving electric delivery vehicles and on-demand drone technology.

5.1.2 Tracking technology

A big problem Walmart has to solve is the accurate tracking and movement of its products through the supply chain. Walmart was an early adopter of RFID technology to increase stock visibility and is still using it on its apparel stock. The technology has not been rolled out across its supply chain because it is currently too costly to do this on low value stock.

Labelling and scanning every case at every touch point from regional distribution centers to the store shelf to enable sight of inventory is still cost prohibitive. Instead, Walmart is still heavily reliant on the use of standard GS1 barcodes that are scanned electronically using lasers and camera-based technologies to identify and track products across its supply chain.

From an inventory management perspective, it has focused on how it can maximize the amount of Stock Keeping Units (SKU) it can store at its fulfillment centers because the more SKU selections then the more control it has over the product choice and delivery commitments it can make to its customers.

Walmart has developed software systems to improve accuracy by, for example, sending real time data to stocking teams each time an Associate logs an item to be out-of-stock on a shelf. This prompts the stocking team to replenish the shelves faster than it would previously have done so, reducing the time an associate loops back on ‘the exception pick walk’, the item is back on the shelf.

In transportation, Walmart’s extensive fleet of long-haul trucks clock up millions of miles delivering products across the US every year accounting for 72% of its CO2 emissions. According to one interviewee, the biggest investment from a technological
perspective has been in technology and software that enables it to deliver more while driving few miles. In 2020, Walmart launched a new inbound Transportation Management System (TMS) to optimise routes and schedule planning.

The cooling of its refrigeration trailer units accounts for 21% of Walmart’s overall CO2 emissions every year. Walmart’s senior transportation director told us:

‘It’s typical that when an empty trailer hits the yard the pre-cooling will be switched on manually resulting in an excess of 12 to 14 hours of cooling, which burns unnecessary diesel fuel.’

To address this, Walmart is piloting smart yard management systems that autonomously trigger the efficient cooling of its refrigeration trailer units. One interviewee said, by integrating an IoT device in every trailer to automate pre-cooling, Walmart is predicting it will be able cut 202 million lbs of CO2 emissions and save $17m in diesel fuel bills a year.

5.1.3 Artificial intelligence

For suppliers, Walmart is experimenting with the use of AI software that reads and renegotiates active supplier contracts via a chatbot. This is reportedly enabling Walmart to avoid the involvement of expensive professionals for the many thousands of small value agreements it has in place. It has also started using automated product reordering systems and is working closely with suppliers to identify further opportunities to integrate its sales forecasting.

In fulfilment, Walmart has launched AI-based software – called ‘Global Integrated Fulfilment’ (the in-store equivalent to a Warehouse Management System). This helps associates pack orders faster by using mobile apps that optimise pick walks and by automating decisions about product substitutions when an ordered item is out-of-stock. In pickup, this software also suggests ways associates should talk to customers about substitutions in a personalised and human way. As Walmart’s Vice President for in-store fulfilment and automation said:

‘Customer pickup is the biggest interpersonal transaction we have at Walmart. We develop software that allows associates to speak to customers to create a ‘wow’ customer experience. For instance, “Hey, we had to substitute your strawberries for blueberries, and we know blueberries don’t seem like a great substitution but, if you needed fruit for your kids’ breakfast in the morning, we wanted to bring you something”, and, when you say it that way, customers were like “oh, wow, that’s incredible”.

The next evolution was to build a smarter system to put these decisions into the customer’s hands. So now customers are told about products low in stock or prone to substitution and given a choice of substitution options. The handheld devices also allow associates to explain these substitutions to customers. One manager reported:

‘We were really surprised how important this small interaction with the customers was, and how it improved customer associate interactions, making it more personable than just handing over their bags.’
From a sustainability perspective, Walmart is developing packing software to help it reduce delivery box sizes – both to reduce waste and increase delivery capacity. One supply chain Vice President said:

‘We’re looking to automation solutions to minimise the amount of air we ship in every box because when you do that it’s less corrugated materials, you don’t have to fill the space with air bubbles or other damage materials, and you can fit more boxes in trucks, so your transportation costs improve.’

It is developing Last Mile Delivery (LMD) software to predict when an associate will have completed packing an order so it can efficiently ensure it has one of its crowdsourced delivery service providers arriving at that point. It is also looking at how technology can help speed up the delivery process of its own delivery fleet by developing an Outbound Transport Management System (TMS) that will reduce the miles travelled when delivering goods to consumers.

So, no part of Walmart’s global supply chain is being left untouched by advances in automation technology. The technologies that it is adopting are aimed at both improving the customer experience and reducing operational costs to the business; they are also changing some of the ways associates interact with their customers in a more personable way.

### 5.2 Drivers of supply chain automation

The adoption of automation technologies is driven by three core business drivers: cost (ability to run operations efficiently), capacity (ability to meet customer demand) and capability (ability to deliver high quality service) – as illustrated in Figure 6.

A Senior Vice President explained:

‘We see opportunities for us to make investments in technology that are going to improve our processes, making us more efficient and driving better service for customers.’

The Covid-19 pandemic has been a further catalyst for supply chain technological innovation efforts taking on a new urgency. Walmart’s transformation efforts have had to focus on enabling technologies that will help deliver services to customers more conveniently and faster.
5.2.1 Customer

More shoppers than ever before have been using Walmart’s pickup and delivery services since the lockdowns imposed by the pandemic. This has led to customers expecting and demanding simplified purchasing and rapid delivery, in particular in response to the competition from the next day delivery services provided by Amazon Prime. Walmart’s goal to give customers what they want and when they want it is an important driver of technological investment, as well as respond to competitors entering the sector.

One Senior Supply Chain Vice President said:

‘Our customer drives the investments we make, and our customers want a better selection of goods, better prices over time and things delivered to them in more convenient ways’.

Areas of particular focus are technologies that enable convenience, speed, excellent service, affordability, availability and personalization.

5.2.2 Cost

Cost is the biggest factor in any decision about technological adoption. Any investment needs to be aligned with Walmart’s Everyday Low Price (EDLP) strategy, which aims to offer low prices to customers throughout the year, and not only during seasonal ‘sales’ periods. This means its ability to squeeze the value out of the operational running of the business is a priority when looking for opportunities to make technology investments. A Vice President from supply chain engineering summed this up:
‘Our ‘Save Money, Live Better’ motto is our company’s DNA. We’re constantly looking for ways to optimize our costs; we automate where we can have the biggest impact on driving up productivity and reducing variable costs.’

Its operational costs for running conventional warehouses are as low as they can go when compared to retail industry averages, according to an interviewee. To go further, Walmart is looking for opportunities to fully automate buildings, which can save up to 50% of the operating cost of running a conventional building.

5.2.3 Capacity

Capacity requires balancing a whole host of challenges to meet peaks and troughs in customer demand (e.g., just-in-time inventory management, staffing, efficiently turning cars, creating delivery slots, finding crowdsourced drivers when needed). Rapid expansion in online grocery shopping has resulted in capacity becoming an increasingly important business driver for technological investment. A senior director in next generation supply chain technologies said:

‘At the height of the pandemic, we simply didn’t have enough capacity in our stores for the number of orders we were getting every day. We’re leveraging technologies to improve economies of scale.’

Walmart has typically invested in labour to increase capacity but where this cannot keep up with demand – like during the height of the pandemic – it is looking to automation technologies to expand capacity quickly and achieve a lower level of variability across the supply chain.

5.2.4 Capability

Giving customers what they want and when they want it requires a core set of capabilities to ensure product availability and speed of service. This is easier said than done, as one Vice President in fulfillment and automation highlights:

‘Retail is notorious for having horrible inventory accuracy – there’s a myriad of reasons why this happens but retailers struggle with this and it exposes a lot when you’re trying to pick online, with phantom inventory increasing the risk of a substitution or an ‘out’ for a customer.’

In 2019, Walmart turned on its next-day delivery capability for customers, prior to this it had only had a two-day delivery capability. Inventory visibility, inventory accuracy, product choice, rapid delivery and timed deliveries are all key capabilities that the company is looking to technology to enable.

5.2.5 Sustainability

Environmental impact was not mentioned in an unprompted way as a key business driver of digital and technological supply chain automation and innovation. However, probing questions were asked to ascertain how supply chain productivity is aligned to
environmental performance, and where technological innovation is most needed to deliver a sustainable supply chain.

Retailers are looking to automation technologies to help them reduce the significant waste in their supply chains. The biggest business drivers for investing in automation technologies in retail supply chains include improved customer experience, revenue growth, keeping pace with competition, reduced operating costs and improved inventory management (Manners-Bell and Lyon, 2019, Zebra Technologies, 2017).

**Responsible business practices** are getting more attention from customers, investors and regulators and, as such, are also becoming an important business driver of technological innovation. Customers increasingly want to see big businesses taking action on climate change across the world (Phillips, 2016), although in the US concerns are politically divided (Fagan and Huang, 2019). Over half of US consumers are concerned about the environmental impact of packaging (Feber et al., 2020). However, factors like price, quality and brand rank more highly than packaging, environmental impact and social concerns when making purchasing decisions. Conversely, the British Retail Consortium (BRC), the trade association for UK retailers, found 79% of UK customers are changing shopping preferences based on the social and environmental impact of their purchases and 88% want brands to help them live sustainably (British Retail Consortium, 2020).

Net zero commitments to eliminate waste and initiatives to embed social and environmental expectations across supplier networks have been adopted by many large corporations like Walmart, Amazon and Tesco. More than 60 retailers in the UK are backing the BRC’s UK industry-wide plan to reach net zero by 2040. Helen Dickinson OBE, Chief Executive of the British Retail Consortium, said: ‘Never before has an entire industry been so ambitious in tackling climate change.’ Digital technologies and the data they generate will have an important role in enabling sustainable supply chains for the future. Understanding the factors shaping technology adoption and diffusion are essential to understanding how effective they will be at this.

Respondents from our interviews said that company leaders are increasingly thinking about the role automation and technology can have on end-to-end sustainability within its supply chain in order to meet its zero emissions and waste goals, and to meet customer expectations. A Senior Vice President said:

‘If you care deeply about customers, you also care about the environment and the communities they live in. If you’re not taking a sustainable, regenerative approach with how you operate over the long term, you’re going to negatively impact those communities and those customers your serve. So, you have to think of the two things together.’

The challenge for the company is to ensure it has economically viable solutions. Although there are technologies that can help it mitigate against its current environmental impact, cost is a barrier to the speed of adoption of these technologies, if it does not align with the company’s values to keep costs low. For instance, the cost of a new electric truck is $350,000 compared to $86,000 for a diesel yard truck. So, at present, sustainability initiatives have to be cost-neutral or provide cost-savings.
5.3 Technology adoption decision-making

Speed, flexibility and purpose underpin decisions about technology adoption. Demonstrating it can operate as fast as a small company is a priority to the way it develops and iterates on its digital transformation journey. This mindset flows from the very top of Walmart’s leadership team with Doug McMillon, Walmart’s President and CEO since 2014, seeing it as the route to successful digital transformation. One supply chain Vice President’s said:

‘We had our first eCommerce dark store opened to customers in 32 weeks; so, we had gone from a retention pond at a bank that we purchased, excavated, put a building on and had up and running for customers in 32 weeks, and I think that was to demonstrate to the world that we had the ability to operate in a digital age and work quickly.’

This ambition to operate as fast as a small company has driven agile ways of working and an acceptance that failure helps growth and innovation. As another supply chain Vice President’s pointed out:

‘When your driving business innovation there needs to be a commitment to move fast, fail fast and iterate faster. We’re never going to get it right first time, things will fail so you need to quickly iterate and show progress.’

Essential factors affecting technology adoption decisions were related to ways of working: identifying the appropriate technology, identifying the best technology partner, and metrics to evaluate success (Figure 7).

5.3.1 Technology identification

Identifying the right technology starts first with the customer needs and expectations, or operational or employee problems, rather than the technological capability in search of a problem to solve. While this may sound obvious, supply chain managers said they often had technology suppliers approach them with a solution without fully considering the problem it was trying to address. The Vice President of supply chain engineering said:
'The technology is not our starting point. You might say everything starts with our customers and then our operations and associates. If there is a problem, we look at how we can solve it. That might be through automation or it might be through better systems and processes.'

Another of our interviewees, the Senior Director of last mile delivery made a similar point:

‘There are lots of interesting technological innovations, but we focus on applying technology where there is demand or need. So, you might only use drone technology where there is a demand for home delivery, but established delivery service networks don’t exist.’

Walmart has made significant investments in bringing software capabilities and resources in-house. This is to help the development and execution of customer-focused product design and to speed up the transition from a bricks-and-mortar retailer into the digital age. As illustrated by a Senior Vice President in engineering and software:

‘From a software standpoint, most of our solutions are developed in-house. Since Doug took the reins, we’ve been making more and more investments to make Walmart a more digitally native organization. We’re relying less on software from third parties because internally developed software will be more connected to our customers and more connected to our business.’

This illustrates how technological change is shaping the innovation work chain in requirements for particular kinds of labour within the organisation.

### 5.3.2 Collaborative and flexible partnerships

The company has a sharp focus on developing technology solutions that are unique and will give them first-to-market competitive advantage. It outsources its automation hardware development, relying on highly collaborative and flexible partnerships, indicative of the broader Innovation Work Chain perspective developed here. As one Vice President in engineering said:

‘We don’t buy a lot of off-the-shelf hardware. Our engineers spend a lot of time trying to understand the problem and then we partner closely with vendors that can help us build the right solution.’

These engineering staff scan across industries to identify what advanced technologies are being developed and used. They partner with both large well-established suppliers that have a proven track record of commercialising technologies and small start-ups; they can often be more flexible in helping them develop bespoke solutions. A senior director of emerging supply chain technologies said:

‘Walmart works at both ends of the spectrum, with well-established companies and with very small startups. If they have an idea that we think is going help solve the problems we have then no company is too small.’
In the start-up world, Walmart has a strategic partnership with an organisation called Plug and Play, a venture fund and technology accelerator, that knows the start-up market very well. Plug and Play works with both early and growth-stage start-ups to help them build and develop their businesses and meet major corporate clients. Funded by its corporate clients, it has a supply chain office in Arkansas, the home state of Walmart’s head office. Its other corporate clients include other local firms like Tyson Foods and the transport company J.B. Hunt. Its location enables greater engagement and availability to these major supply chain corporate clients. For Walmart, Plug and Play is its first point of contact for sourcing and connecting it with the best technology partners. Plug and Play’s supply chain operations director said:

‘It’s not just about working with start-ups. One of the big pluses we have for our fee-paying corporate partners is they have the opportunity to work with other big corporations who have an interest in trying to further their business innovation wise. So, there is this other opportunity to help them work closely with and learn from other businesses they are not in direct competition with.’

This illustrates how technology innovation and adoption are linked, not only to the organisation but also to the wider ecosystem they are located in, even for a major corporate like Walmart. The company nurtures a long innovation pipeline with resource focussed entirely on identifying and incubating the development of emerging technologies that are two or three years from being ready to roll out across the business.

5.3.3 Measuring the success of technological innovation

Whether a technological intervention solves the problem it was developed to solve is the ultimate measure of success and a determining factor for wider rollout. For instance, Walmart had been experimenting with Bossa Nova robots, which scan shelves to check for product availability, but these were removed after they were found not to be as efficient as staff. Similarly, it removed automated pick-towers that had been put in stores to dispense online orders (much like a vending machine) after it was found that customers preferred picking up their orders from outside the store.

Walmart draws on a host of value creation performance measures to evaluate the success of technology adoption, implementation and rollout. These reflect the iterative process of adoption, development and diffusion. The mix of metrics vary project-by-project but broadly cover everything from the impact on operation efficiency, sales and customer experience. It uses standard customer experience quality metrics like customer satisfaction (CSAT) and net promotor score (NPS), which is the proportion of customers who are likely to endorse the company. A Vice President in fulfillment and automation talked about the importance of having a balanced approach to measuring financial and operational impact:

‘You can’t just pound any one metric; you must have a balanced scorecard. So, if we’re going to push on productivity and speed, you need to make sure you don’t take a hit on quality. Those things all need to be looked at together.’
Increasingly, the impact on environmental sustainability is being integrated into this balanced scorecard. For example, the impact on fossil fuel use or the recyclability of materials.

A key productivity metric Walmart looks at is Units Per Labour Hour (UPLH) – which assesses how busy staff are by measuring the picking rate per hour of work. Picking is where most hours are spent in Walmart’s labour model.

Another measure of UPLH looks at the amount of labour spent on the dispensing of goods. Walmart gives its pick-up customers a 5-minute promise, which is a commitment to having shopping out and ready to load within 5-minutes of the customer’s arrival. Calculating the number of staff required to perform this service can be challenging and they estimate they currently allocate 2.5 more people than would be needed according to its labour model. For example, it has a 10-minute turnaround for every customer so, in theory, one person should be able to handle six customers per hour. In reality, 30 to 40% of customers will arrive at the top of an hour-long delivery window so they have to overstaff in order to avoid any disappointment or customer complaints. This metric is also translated into Hours Per Order (HPO), i.e., how much time is spent on each order. This is easier for managers to evaluate effective performance. It is the interaction of these performance measures alongside the introduction of new delivery technologies that shape the labour landscape in how jobs across the innovation work chain will develop in the future. At present this has largely been a learning and iterative process, catalysed by the effects of changing shopping patterns during the pandemic.

5.3.4 Legacy systems and barriers to the speed of technological transformation

The transformation from an established manual supply chain operation to highly autonomous systems is complex, costly and risks interrupting business-as-usual operations. Legacy systems, capabilities and costs are three challenges to the speed at which automation technologies are being adopted.

First, legacy systems and operations can slow the progress of digital transformation. One supply chain director illustrated the challenge Walmart faces when managing many of its legacy systems that have been developed as the business has grown:

‘From a technology perspective, we’re spending a lot of time developing systems that are one version of the truth. So, we have 14 different warehouse management systems that have grown out of various acquisitions over the years. But, as you would expect, this leads to inefficiencies across the workforce, so we need to consolidate them without impacting the day-to-day operations. This isn’t easy.’

Second, technology supply capabilities can be a challenge to technology integration. Technology hardware companies often do not have software capabilities so they develop the hardware without understanding about how it can be integrated into the wider digital ecosystem.

Third, cost is a barrier to what can be adopted. RFID technology is a case in point. While this technology can store much more information than a barcode and vastly
improve inventory visibility and management, the set-up and running costs are barriers to adoption. Each tag costs around 5 cents which does not sound like a high cost to bear but when used at scale on low value products is harder to justify. One of the interviewees who works on identifying emerging technologies illustrated this point:

‘We struggle at times with companies who come to us with technology like RFID because they struggle with the economy of scale with Walmart. They might think that 5 cents a tag is cheap, but they don’t realize we ship 1.5 billion cases sometimes. It might be cheap if you’re shipping an expensive product like an iPhone but it’s more than we can tolerate for the value of products we ship.’

To manage some of these challenges, Walmart is taking two routes on its journey to full supply chain automation. First, a next generation path using end-to-end automation technology to either retrofit or build new fully automated distribution centres for both perishable and ambient products. This is being deployed in its newly launched high-tech distribution centre in Shafter, California.

A second path designed to help it manage costs and avoid business interruptions involves light or medium automation using ‘bolt-on’ or ‘bridge’ technologies. These can be invested in over the short-term to get them closer to longer term full automation. This path focuses on how small pieces of the process can be automated. For example, this would include autonomous systems that help stacking and picking or mobile robots that can pick up and move pallets and cases around the building. Additionally, there is experimentation with wearable technology to enhance manual process such as routing pick walks.

Barriers to automation include cost, capabilities and technological legacy systems. At the same time iterative experimental projects are assessed to test new processes before they are scaled up. The long-term assessment of the consequences of these on innovation work chains within retail and the use of labour is evolving.

5.4 Employment consequences of supply chain automation

The future of retail will involve more technology than ever before, so Walmart is focussing on expanding what it calls its ‘digital workforce’. In doing this, it is adopting labour-saving technologies that Frey (2019) has described as ‘labour-enabling’ and ‘labour-replacing’ to deliver productivity growth and operational efficiency, and to enhance the customer experience.

5.4.1 Labour-enabling technology development

The introduction of automation technologies will increase staff productivity by automating simple tasks, by enhancing the efficiency of others or by motivating performance through gamification. For instance, its AI-based ‘Global Integrated Fulfilment’ software reduced 15% off the time it took associates to do their pick walks for online orders by zoning their product picking. A second iteration of the tool took a further 10% off the time by more efficiently routing associates through the store.
The company is adding gamification functionality to its software to increase staff productivity through competition, as a Vice President in fulfilment and automation explains:

‘We’re doing things like gamification. When you introduce labour targets in a warehouse, you typically get about a 10% productivity bump. But labour targets can be harsh so rather than doing that we’re trying to gamify job tasks. It’s like using Strava for the workplace - so through the app you can see if you’re the top associate for picking that day or you get the most likes from a customer. We’re working with behavioral scientists and game designers to build a better version of what we currently have, and to try to get into the psyche of the Associate. And we think we’ll get a lot of engagement from this.’

The extent to which technological gamification initiatives like these will change and motivate employee behaviours and promote employee engagement is yet to be seen. Much is likely to depend on how much these technologies are perceived to enhance job roles, rather than threaten them, and the extent to which staff engage with them in a meaningful way.

5.4.2 Labour-replacing technology development

Considerable priority has been given to replacing many of the manual tasks across the company’s supply chain with automation technologies to both increase capacity and deliver operational efficiency. However, the use of terms like ‘labour-replacing’ is naturally a sensitive subject.

Walmart’s supply chain executives stressed that technological innovation is not about replacing humans but about creating job opportunities that are better quality or that attract different skill sets. For example, more emphasis was given to how job roles will require skills to consume and understand data or to fix electrical systems, as well as improve the customer experience. Walmart’s investment in software engineering skills was highlighted but, while talking about fully automated distribution centers, one senior engineering executive talked about the expansion of other technical roles:

‘Our costs are low in terms of industry standards when it comes to running traditional buildings. But an automated building costs us about 50% of the operating costs. But the interesting thing is your maintenance and technicians – what I would call your technical jobs – go from being less than 10% of the cost to being close to 30% of the cost.’

The focus, it says, is on replacing the labour intensive and physically demanding roles where there are high levels of labour turnover. The difficulty of hiring people for physically demanding jobs was highlighted by one of our interviewees:

‘It's hard to know if you're going to be able to keep hiring people. We have seen there is a diminishing workforce that wants to do the highly manual, highly physically demanding jobs that we do in our warehouses.’

Walmart says that it can take the labour savings from here and apply them to more customer service focused roles. It says that customer-facing roles and roles that are
less physically taxing are much more rewarding for the staff and, as a result, lead to better retention.

The challenges of cost, complexity and capabilities affecting the speed of technology adoption and automation across Walmart’s retail supply chain chime with themes picked up in the wider literature. This is discussed in greater detail in the following section.

6. Discussion and Conclusion

The considerable customer migration to grocery ecommerce is set to continue beyond the COVID-19 pandemic. Technological advances open new opportunities for retailers to improve customer experiences and operational efficiency. This study set out to understand how one large-scale retailer is deciding which technologies to adopt across its supply chains and their implications for employment. We identified three automation technologies that will impact the experience of customers and employees – robots, tracking technologies and AI.

Of all the technological innovations, warehouse automation is predicted to lead the way in terms of industry-wide adoption over the next five years. With a host of robotic, tracking and AI technologies working together to make the smart warehouse of the future a reality. The 2021 opening of Walmart’s first high-tech distribution centre, which is forecast to move 40% more products at half the cost of a traditional distribution centre, signals how the company is moving along this trajectory.

Walmart is experimenting with and implementing technologies to give a better customer experience, improve productivity and lower operational costs within a well-established traditional ‘bricks and mortar’ organisation. It is looking to technology to help it operate efficiently during low demand times and when demand exceeds capacity, like during the height of the pandemic. But perhaps the biggest advancement towards full automation for Walmart will come with the successful development in robotic arms that make complex human-level capabilities like picking and manipulating individual items a possibility.

Despite a panoply of initiatives being introduced across the breadth of the supply chain, the pace of change is likely to be slower than is often represented in the literature and media. Automation can be a long and complex process and it is likely to be some years before the real value and impact is felt (McKinsey Digital, 2019); the pace of change is both rapid and slow, at the same time. There are a number of factors that impact the pace of technological innovation: cost, complexity and capabilities.

Cost: Technological innovation can reduce operating costs and improve the significant waste in today’s retail supply chains, but they are also a significant cost to any business. End-to-end supply chain visibility is the holy grail for retailers, especially as the growth of eCommerce adds greater complexity and cost to business operations. However, although existing IoT tracking technologies, like RFID, can enable greater supply chain efficiency, transparency and agility, they are still cost prohibitive to roll it out across the whole supply chain: it is not appropriate for the wide range of low value cold, wet and dry storage goods it sells. While environmental sustainability goals are becoming an ever more important driver of technological innovation, the speed of
adoption is limited to whether or not they are cost-saving or cost-neutral to implement. As a result, their impact on employment is likely to be low at present.

**Complexity:** The transformation from an established manual supply chain operation to a highly autonomous system is complex and risks interrupting business-as-usual operations. Walmart has to factor in the management of *legacy systems* into its transformation journey. So digital transformation requires an incremental and iterative process that can bridge the journey from highly manual operation to a high-tech business over time, without impacting today’s customer service levels.

**Capabilities:** People and organisational capabilities are essential to successful technology integration. As Christensen (2016) argued, organisational values – like driving everyday low costs – could limit a company’s capabilities and ambition for change. McKinsey (2019) emphasised the need for a clear costs-benefit analysis of any technology investment. Beyond short-term benefits, an investment strategy needs to focus on how investments today can bring longer term value. Walmart’s 2021 announcement to invest a further $14bn to boost supply chain capacity and automation would indicate longer-term benefit planning.

With regard to how technology across the supply chain impacts on Innovation Work Chains (IWC) we found that there had been considerable investment in bringing software and engineering capabilities in-house alongside a network of external partnership to deliver its hardware requirements. However, external vendors do not always have the capabilities to think about how the hardware it is developing will be integrated into wider business eco-systems. To overcome this barrier, retail businesses need to ensure they bring in the right capabilities to support smooth integration and rollout. Highly collaborative and flexible business partnerships are also essential to avoiding a disconnect between hardware and software development.

The full impact of automation on retail workers is yet to unfold but *labour-replacing* and *labour-enabling technologies* will have an impact on the way people work. There will need to be active management of the impact that technology will have on the changing shape of labour models. Businesses will need plan to ensure they have the right mix of talent. Importantly, responsible businesses will need to think about how it supports those most at risk of job displacement across the innovation work chain – potentially looking at regional rollout plans to minimise impact on whole communities.

In conclusion, retail supply chain management is expected to see significant disruption over coming years as a result of advances in automation technologies. Walmart is looking to these technologies to improve customer experience, grow revenue, lower costs and to remain competitive. Though not yet a lead factor in driving purchasing decisions in the US, environmental impact is emerging as an important trend in driving technological transformation. However, the speed of adoption and diffusion of automation technologies is hampered by the cost and complexity of technological innovations and the legacy systems that these innovations need to integrate into or replace.

Automation technology will change both customers’ and employees’ experiences. To increase chances of a successful and scalable programme of automation the right investment strategy, cross-functional governance and core capabilities (from inside
and outside the business). Businesses may also need to be prepared innovate ahead of demand to gain competitive advantage. Changing labour models across the innovation work chain will need to be actively managed to ensure the right mix of recruiting new talent, advancing training and supporting transitions for those at risk of job displacement.

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Stopford and O'Reilly

Innovation Work Chains in US Retail


Stopford and O’Reilly

Innovation Work Chains in US Retail


