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Walmart's Blockchain Quest: Integrating New Technology into a Complex Supply Chain

Frederick Durmot[i] paced around his office. It was late 2017 and Walmart's director of food safety was preparing for a speech. In one hand he held flashcards with talking points. In the other he gripped a steaming cup of coffee. Durmot's speech to Walmart's food safety department and supply chain team was in less than one hour, and he still had lingering questions about the company's new blockchain initiative with IBM.

The year had been truly exemplary for Durmot and his Walmart food safety colleagues. They had entered into two pilot programs using IBM's blockchain technology to trace pork and imported animal protein in China and better understand their sliced mango supply chain. As 2017 came to a close, the pilot programs had been completed and Durmot had been impressed with the results and findings. He was convinced expanding the programs into full-blown production and collaborating with other suppliers was the right path. But he knew some of his team remained skeptical. Many were resistant to the complex new blockchain technology, which had been hampered by hardware and connectivity issues. Blockchain requires internet access, and many of Walmart's rural suppliers did not have easily accessible wireless connections. Blockchain would also demand enhanced tracking, data quality adherence, and software capabilities. While suppliers were increasingly likely to have smart devices and internet, blockchain's advanced technology requirements still posed a significant hurdle.

Transparency was another primary issue. Durmot believed Walmart should be up-front about its supply chain to encourage trust among its suppliers and customers, but he knew the strategy carried risks. While many in the food industry outwardly lauded collaboration through data sharing and transparency, in practice they were concerned about sharing sensitive information and revealing industry secrets. Durmot himself was nervous that blockchain technology and increased supply chain interconnectivity could unearth damaging information about Walmart's suppliers and reflect poorly on the company.

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[i]   Frederick Durmot is a fictional character.

Still, he felt the additional data blockchain could provide would ultimately give Walmart the ability to fix supply chain issues, as well as the opportunity to control its own narrative and prevent public relations scandals.

Durmot wondered whether blockchain technology was truly equipped to handle Walmart's unique infrastructure, scope, and complexity. Would blockchain meet the high expectations of the Walmart team and its global customer base? Would the company garner enough value to warrant the costs of implementing blockchain? And, could Walmart adopt blockchain technology in other areas of its supply chain, beyond food?

Durmot knew implementing a few larger pilot projects and use cases would be crucial to the success of the blockchain program. He just had to secure buy-in from some of his skeptical colleagues before Walmart could move forward.

Understanding Walmart

Sam Walton opened the first Walmart in Rogers, Arkansas, in 1962.[1] The store was small and did not sell groceries, but would eventually grow into the largest food retailer in the United States.[2]

Walmart went public in 1970 and by 1980 had reached $1 billion in annual sales. In the midst of its growth, Walmart launched several other business models, including Sam's Club in 1983 and the first Walmart Supercenter in 1988. In 1991, the company opened its first international store in Mexico City, and by 2002, Walmart topped the Fortune 500 list of the world's biggest companies.[3] Walmart's net sales had reached nearly $500 billion by 2017 (see **Exhibit 1**).

Exhibit 1
Walmart Net Sales Worldwide: FY2006-FY2017 (in billions)
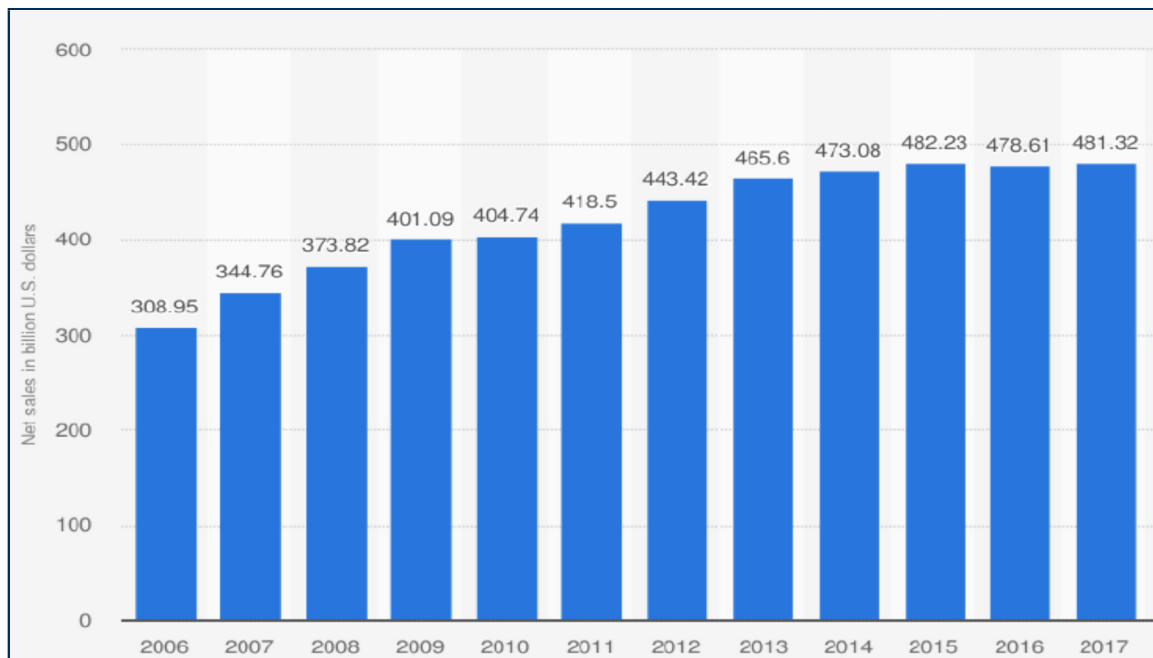
Source: "Walmart's net sales worldwide from fiscal year 2006 to 2020." *Statista*, 2021. https://www.statista.com/statistics/183399/walmarts-net-sales-worldwide-since-2006/.

As Walmart grew, the firm attempted to address its social and environmental impact. It launched the Walmart Foundation in 1979 and Walton Family Foundation in 1987. Both foundations provide local community grants and other philanthropic giving. In 2005, Walmart contributed 2,450 truckloads of supplies and $18 million to victims of Hurricanes Katrina and Rita.[4] The same year, the company set a three-part environmental commitment to pursue 100% renewable energy use, create zero waste, and sell sustainable products. In 2017, Walmart launched Project Gigaton, which aimed to reduce its supply chain greenhouse gas emissions by 1 billion metric tons.[5] The company also focused on labor practices, investing $2.7 billion to raise its minimum wage by 24% from the federal level of $7.25 to $9 per hour and implement skills-based training in 2015.[6] As 2018 approached, the company was preparing to raise its minimum wage again, to $11 per hour, and expand its maternity leave program.[7] Despite its many attempts to improve its social impact, Walmart's workers relied on $6.2 billion in public assistance in 2013 and was one of the top employers of Supplemental Nutrition Assistance Program beneficiaries in the United States.[8]

Walmart began to increase its innovation investments in the 2010s. In 2016, the company introduced the Culinary and Innovation Center and Walmart Pay, an app-based, touch-free payment system.[9] The company launched Store No. 8, a technology incubation division focused on "transforming the future of retail," in 2017.[10]

Walmart's retail locations began carrying food in 1988 when the company launched the first Walmart Supercenter in Washington, Missouri. The store combined Walmart's typical retail offerings with a full supermarket. By 2001, Walmart had become the largest grocer in the United States.[11] And, by the end of the calendar year in which Durmot would make his blockchain decision, the company would command a 25% market share of all U.S. grocery sales, prompting critics to express concerns about a potential monopoly. According to the nonprofit Institute for Local Self-Reliance (ILSR), "no other corporation in history has ever amassed this degree of control over the U.S. food system."[12] ILSR data indicated the only grocery store ever to have reached a similar level of dominance was the A&P chain, which commanded 16% of the market in 1993.

Walmart's food business and growing market share introduced new regulatory and logistical hurdles, as well as a heightened responsibility to customers. In 2016, the company reported that 140 million Americans visited Walmart stores every week, and the majority purchased food items.[13] To serve its high volume of customers that expected groceries, clothes, and home appliances, Walmart would eventually grow its supplier network to more than 2,800 firms and spend $15 billion annually on procurement.[14]

As Walmart's supplier network and customer base grew, consumers and regulators worldwide began pushing for greater supply chain transparency to ensure retailers prioritized labor rights, social justice, and environmental preservation. The push proved especially important for Walmart's grocery business, as food safety concerns increased and technological advancements made tracing ingredient origins more efficient. Walmart customers expected their grocery purchases to be socially and environmentally ethical, and the company knew it had to deliver on the expectation to remain competitive.

Food Safety Concerns

A number of high-profile cases brought worldwide attention to food safety issues in the 2000s. In 2008, regulators discovered melamine, a chemical compound used in plastic and fertilizer production, in milk and baby formula sold in China.[15] Officials first identified the chemical in Gansu Province and eventually implicated 22 Chinese companies in the scandal. Six infants died from kidney stones linked to melamine and, of more than 300,000 babies who became ill, 54,000 were hospitalized.

Beginning in 2007, the amount of beef recalled in the United States for E. coli contamination increased dramatically, and by 2010, concerns about superbugs, or antibiotic-resistant bacteria, surrounded the food industry.[16] Regulators cited Fresno-based Beef Packers Inc. and Denver's King Soopers as the source of an outbreak of an antibiotic-resistant strain of salmonella in 2008. Officials then traced multiple E. coli outbreaks to U.S. producers Cargill and Nestle in 2009. Also in 2009, an Illinois McDonalds location was cited as the source of a hepatitis A outbreak that exposed more than 10,000 people. Additionally, JBS USA and Fairbanks Farms each sold more than half a million pounds of E. coli-contaminated ground beef to customers. And, Peanut Corporation of America filed for bankruptcy after regulators recalled 3,918 separate products made with the company's peanut butter, an incident that cost the government and food companies more than $1 billion, making it the costliest food recall in history at the time.[17]

In response to the melamine case and other highly publicized food safety scandals, the U.S. Congress enacted the Food Safety Modernization Act in 2011. The legislation put in place stringent food safety protocols, including third party certifications, food manufacturing best practices, laboratory accreditation, and additional food traceability initiatives.[18] Despite the precautions, the United States saw an 83% increase in meat and poultry recalls, a 70% increase in chicken recalls, and a 10% increase in recalls overall between 2013 and 2017.[19] While some of the recalls could be attributed to improvements in tracking technology, the increases put pressure on the food distribution industry to ensure greater transparency and accountability in the supply chain.

As the largest U.S. grocer, Walmart's supply chain had come under intense scrutiny by customers, competitors, and industry regulators by 2016. The company therefore worked to prioritize transparency and efficiency. Its focus was on two main supply chain issues: (1) the source of harmful bacteria and additives in its products and (2) tracking and isolating the toxins' introduction as quickly as possible. While ensuring complete food safety may not have been possible, Walmart believed it could invest in superior tracing technology to cut down on the time required to recall unsafe food items. The company considered blockchain a prime candidate for these improvements.

A Blockchain Primer

Best known for providing the foundational technology for Bitcoin cryptocurrency, blockchain was developed as a digital, distributed, immutable ledger software. The software was intended to build trust and transparency among transaction parties without independent, third-party arbitrators or intermediaries.[20]

As a ledger, blockchain recorded events—everything from what happened to physical or digital objects, to interactions and agreements among parties. Blockchain software was distributed, i.e., held on multiple computers called nodes, so no single entity had unchecked power over the ledger. Because it was cryptographically secured, it was difficult to tamper with or make alterations to blockchain.[21]

Blockchain's security particularly appealed to large food supply entities like Walmart. The technology could be used to manage the food supply chain while making it difficult for suppliers to misrepresent or miscommunicate transactions. The centralized databases historically used for supply chain tracking were overseen by one or several parties and lacked external checks against collusion. Blockchain's distributed, immutable nature and resulting security could increase users' confidence in the accuracy of supply chain data and make them more willing to provide confidential information.

In the food space, blockchain users could collect and add event data—such as weather, time, mileage, location, approvals, and flavor—to ledger transactions. The blocks of information would then be sent to

distributed nodes, which would verify each transaction's legitimacy. Once validated, the block would be added to the chain and cryptographically locked to prevent future changes.

A pseudonymous group calling itself Satoshi Nakamoto created blockchain to serve as the backbone of the cryptocurrency eventually known as Bitcoin. The group intended to eliminate the need for financial institutions to serve as a third-party mediator between peers and ensure honest transactions.[22] However, Bitcoin and blockchain were never synonymous. Bitcoin relied on blockchain technology and was the most high-profile example of a transaction marketplace using its security benefits. Blockchain itself, however, could be used for a variety of purposes and industries. (See **Appendix A** for additional blockchain technology use cases.)

Food tracing was a complex problem and three unique characteristics made it a good candidate for blockchain-based improvements. Relative to other industries, the global food system at the time of Walmart's blockchain pilot programs was: (1) highly fragmented; (2) complex; and (3) analog. Consolidated industries like banking featured relatively few players, making oversight simple. But due to its fragmentation, the food industry featured many firms doing the same things, such as growing lettuce.[23] However, each supplier might produce lettuce with significant differences, such as in taste and shelf life, for example.

The food system was complex because delivering food from farm to plate involved an intricate web of miles, relationships, regulations, and constraints. Therefore, there were ample opportunities for omissions, mistakes, misinformation, and deception. Additionally, the food supply chain remained relatively analog, especially in the developing world, with recordkeeping and communication occurring manually, on paper, and/or by word-of-mouth.[24]

Blockchain was capable of addressing the food supply chain's challenges by recording everything ingredients experienced in their journey from farm to plate, then digitally securing the information. Fragmentation and complexity would cease to be issues because all supplier data would be readily searchable in digital form. Blockchain could add value to the supply chain by improving health, safety, and more. Companies like Ripe.io, for example, would emerge to digitize the entire lives of food ingredients, from how they were bred, to their look, feel, and flavor.[25] Data on products' genetic features, what they experienced, and how they were perceived would allow food suppliers to uncover ways to redesign systems completely, with major implications for waste[26] and ethical labor.[27]

Understanding IBM

As one of the world's most iconic technology brands, IBM had a history of innovation at the time of its partnership with Walmart, and it eventually became a leader in developing and implementing blockchain solutions.

IBM evolved from a small business in the early 1900s to a globally integrated enterprise.[28] By 2016, the company provided technology solutions worldwide in cloud and cognitive software, business services, and financing.[29] Through its Smarter Planet initiatives, the company had begun to focus on how industries, infrastructures, processes, cities, and societies could be more productive, efficient, and responsive. Smarter Planet became the overarching framework for IBM's growth strategy, and the company promoted innovative ideas like traveler-centric transportation, consumer-centric electric power, and intelligent systems for managing healthcare, water, public safety, and food.[30]

IBM had also worked in supply chain management for many years. In 1977, the company partnered with Denmark to create an innovative, centralized cattle database, which helped the country become a significant dairy and beef exporter over the next 50 years.[31]

IBM unveiled its blockchain technology service in March 2017 as a way to expand its cloud-based offerings.[32] According to IBM, the technology was intended to improve its customers' efficiency and reduce costs and risks, creating synergies among organizations and enabling higher value business models.[33] IBM Blockchain relied on 1,600 business and technical experts working on more than 500 projects. With the ability for new users to join existing networks, build their own blockchain solution, or create a solution with IBM, the company wanted to simplify the technology and commercialize the network.[34]

IBM commissioned a Forrester Total Economic Impact report to identify the costs, benefits, and risk factors of its blockchain software and interviewed its stakeholders and customers about their experiences.[35] As a result, HFS Research named IBM Blockchain "the flag bearer for enterprise blockchain adoption with a leading number of live and in-production networks,"[36] and Juniper Research ranked the company its number one blockchain technology leader.[37]

At the time of its partnership with Walmart, IBM was also preparing to launch Food Trust, an initiative that involved working with industry leaders to increase safety and freshness, unlock supply chain efficiencies, minimize waste, and contribute directly to bottom lines through blockchain.[38]

IBM collaborated with Chainyard to build the technology and network for its blockchain platform. The partners also launched Trust Your Supplier, a supply chain verification network, which they implemented for corporations like Anheuser-Busch InBev, Cisco, GlaxoSmithKline, and Vodafone.[39] IBM built its enterprise blockchain platform standard on Hyperledger Fabric, which uses an open source and open governance approach for flexibility, transparency, scalability, and accountability—ideal traits for the food industry.[40]

Walmart Partners With IBM

Walmart began seriously considering blockchain for supply chain management in early 2016. The technology promised an array of benefits, including reducing supply chain risks in the short- and long-term. However, at the time, few enterprise blockchain applications were available, particularly at the scale Walmart required. The company knew it would need a trusted partner to help ensure the initiative's success and provide ongoing support.

Walmart conducted two critical proofs of concept for its grocery supply chain transparency effort. The company's desire to implement blockchain throughout the Walmart supply chain largely depended on the success of the two initial pilot programs. The first project traced the origins of Walmart's mangoes, which were susceptible to listeria and salmonella contamination. The second involved the Chinese pork industry, which had suffered from credibility issues.[41]

The pilot projects demonstrated much of blockchain technology's promise:

1. **Speed**. The mango experiment began when Frank Yiannas, Walmart's vice president for food safety, purchased sliced mangoes at a Walmart store and asked his team to determine their origin. The team arrived at the correct answer after seven days. By the end of the mango project rollout, supply chain analysts could determine the same answer in 2.2 seconds.[42] By reducing the time required to provide product origin details, Walmart could mitigate millions of dollars in costs resulting from product recalls and consumer backlash against foodborne illness.

2. **Trust.** As the world's largest pork producer and consumer, China had a history of low credibility within its supply chain. Walmart stores had contributed to these issues. In 2011, Walmart was criticized for mislabeling ordinary pork as organic.[43] However, by uploading certificates of authenticity to the blockchain, the company could eliminate this problem.

3. **Reputation**. Walmart had long built its reputation on low prices. The company was not known as a technology leader and, despite its environmental and philanthropic work, it was not known as a leader in transparency or consumer advocacy. By partnering with IBM and launching its two pilot blockchain projects, Walmart could establish itself as a market leader in retail technology and supply chain transparency. Consumers might begin to think of Walmart not only as the lowest price option, but also as an innovative company that cared about their health.[44]

The two pilot projects validated Durmot's initial notions about blockchain technology. It was an effective solution for addressing the risks in Walmart's supply chain. However, as he considered using blockchain for a broader set of grocery products, several concerns still loomed in his mind:

1. **Functionality at scale.** The initial pilot programs had been concentrated efforts looking to achieve specific outcomes. While they were successful, implementing blockchain throughout Walmart's grocery business would require tremendous resources, both internally and from IBM. To date, no other firm had attempted to use blockchain technology at Walmart's scale.

2. **Supplier adoption.** Companywide blockchain rollout would require all Walmart's suppliers to adopt the technology and use it correctly. Missing links within the supply chain would limit efficacy. Walmart had a history of using its purchasing power to influence suppliers, but making them all adopt unfamiliar technology would likely be a challenge.

3. **Transparency**. Would blockchain technology highlight business practices damaging to Walmart's reputation? Would opening its supply chain uncover human rights abuses, similar to what clothing retailer H&M had found several years before in Bangladesh[45] and what Nestle uncovered in Thailand?[46]

The Chain Continues

Even with the success of Walmart's two pilot blockchain projects, Durmot's team wasn't convinced the technology was the answer to the issues the company faced. From the beginning, Walmart's Food Safety Vice President Yiannas had believed the initiative was not just about tracing ingredients in the supply chain, but also about transparency. Yiannas thought the initial use cases proved his intuition correct.[47]

But Walmart featured unparalleled size in the food industry and blockchain technology was still in its infancy. Achieving full transparency within the company's complex grocery supply chain would be a monumental task. Was Walmart up to the challenge? How could Durmot's team ensure blockchain would be considered successful by Walmart leadership, consumers, and the market? If successful, what might full transparency reveal? Was Walmart ready to face potentially unsavory truths?

These questions were just a few of the issues racing around Durmot's mind. As he looked out his office window on Bentonville, just a few miles from where the first Walmart store opened in 1962, he knew this was a pivotal point, not only in the company's history but for an entire industry, as well.

Appendices

Appendix A
Blockchain Real World Use Cases

Sector	Company	Use Case
Identification	Uport	Voter registration in Switzerland
Mobile Payments	Ripple	Mobile payments ledger
Insurance	AIG	Contract-based blockchain to increase transparency and reduce costs
Endangered Species Protection	*Not specified*	Record and track activities of animals at risk of becoming extinct
Energy	IBM	Monitor carbon offset trading
Border Control	Essentia	Store passenger data in the Netherlands
Healthcare	MedRec	Healthcare data storage
Shipping	Maersk	Monitor the maritime logistics industry
Real Estate	Propy	Enable real estate deal completion
Journalism	Civil	Decentralize journalism
Land Registry	National Agency of Public Registry	Land registry title storage in Georgia
National Security	The U.S. Department of Homeland Security	Record and store data captured by security cameras
Tourism	State of Hawaii	Adopt blockchain-based cryptocurrencies
Music	Arbit	Fair wage initiative for musicians
Fishing	*Not specified*	Transparent record of fish capture locations to ensure legality
Taxation	Miaocai Network	Store tax records and electronic invoices in China

Source: "50+ Examples of How Blockchains are Taking Over the World." *Medium @essentia 1*, 30 May 2018. https://medium.com/@essentia1/50-examples-of-how-blockchains-are-taking-over-the-world-4276bf488a4b.

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markets. WDI also provides a forum for academics, policy makers, business leaders, and
development experts to enhance their understanding of these economies. WDI is one
of the few institutions of higher learning in the United States that is fully dedicated to
understanding, testing, and implementing actionable, private-sector business models
addressing the challenges and opportunities in emerging markets.