Transforming Retail with Edge Compute, 5G, IoT and AI

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About this paper

A Pathfinder paper navigates decision-makers through the issues surrounding a specific technology or business case, explores the business value of adoption, and recommends the range of considerations and concrete next steps in the decision-making process.

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Rich joined 451 Research in 2013 with the company's acquisition of mobility research firm Yankee Group. Before that, Karpinski was editor-in-chief of Connected Planet (formerly Telephony), where he led a staff in covering the service provider market. He has spent a career covering high-tech markets – both telecom and enterprise IT – for publications including Interactive Age, Communications Week, Information Week and Network Computing, working in marketing for supply chain software provider E2open and as an analyst for Net Market Makers.

Rich holds a BA from the University of Illinois and an MS from Syracuse University.

Executive Summary

The retail industry has experienced steady disruption over the last decade, with the COVID -19 pandemic further accelerating digital transformation in the sector. The primary technology driver of this change is the confluence of edge computing, 5G networks, Internet of Things (IoT) devices and artificial intelligence/machine learning (AI/ML). Connected retail technologies that enable real-time management of outcomes are key to success. Such technologies are ushering in a new era of retail that is customer-centric, data-driven, personalized and dynamic, providing consumers with seamless physical and digital shopping experiences. Products and services are delivered proactively, predictively and conveniently to customers, while yielding higher profits for retailers.

Methodology

This report on the retail industry and edge infrastructure is based on ongoing research and interactions with enterprise retailers and technology industry participants. Datapoints presented here are primarily from several 451 Research surveys: Voice of the Enterprise (VotE) surveys of IT and OT professionals; Voice of the Connected User Landscape (VoCUL) surveys of consumers and retail merchants, respectively; and a survey of enterprise end users, including retailers, on their digital transformation and edge infrastructure plans and strategies, fielded and analyzed by 451 Research on behalf of Dell Technologies.

Key Findings

- Business leaders in retail planning, sales, marketing and operations face significant challenges: legacy brick-and-mortar retail is evolving, omnichannel operations are the new norm and the expectations of digitally savvy consumers are sky-high. The risk is real: 80% of consumers say they will stop doing business with a merchant due to a poor customer experience.
- Retailers are making digital progress – but it is slow and needs to accelerate. Just 12% of retailers say their customer experience decisions are data-driven today.
- To stay ahead of the game, retail leaders are deploying or planning technology across mission-critical use cases both in stores and in back-office facilities such as distribution and fulfillment centers. Top use cases include smart checkout, customer footfall analysis, real-time fraud detection, robot-assisted picking, packing and shipping, and demand-driven forecasting and fulfillment.
- To deliver those mission-critical use cases, retailers need to modernize their IT to support an intelligent and data-driven edge – IT infrastructure deployed in or close to store venues where consumers live, work and shop. Retailers are busy deploying intelligent edge in the form of app management modernization, IoT sensors, edge compute and storage, 5G connectivity, and AI/ML-enabled analytics. Thirty-seven percent of retail IT infrastructure is currently deployed at the edge; 77% of retailers expect to increase edge deployments significantly in the next two years.
- To successfully deliver the intelligent edge, retail lines of business (LoB), operational technology (OT) and information technology (IT) executives and teams must work closely together to align business needs, digital processes and technology requirements.

Retail Has Reached the Tipping Point of Dramatic Change

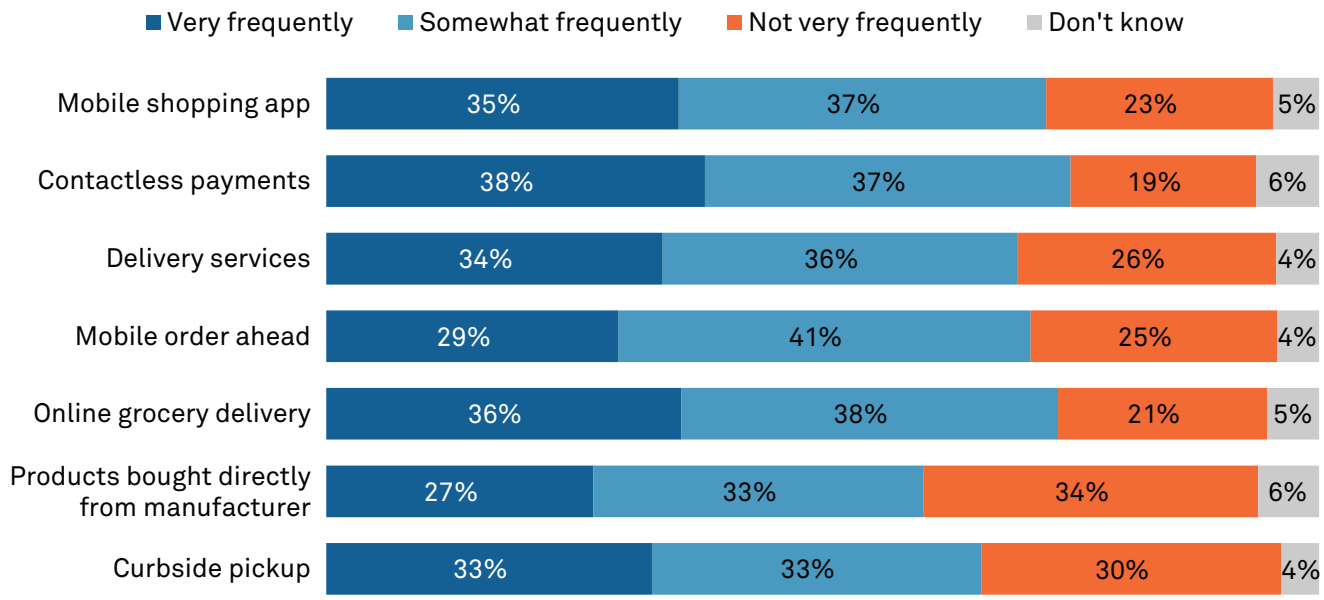
Today's retail industry is unlike anything that has come before it. E-commerce, smartphones and mobile apps have disrupted traditional retail – and with it, consumer expectations and requirements. Many brick-and-mortar stores are closing or being reimagined as entirely new entities. Traditional mass marketing has given way to more customized and personalized customer relationships with high expectations regarding recommendations, ease of use, quality of service and speed of interaction.

Leaders in retail sales, marketing, IT and operations face real risk. Those that delay or get this digital transformation wrong can become irrelevant overnight – or worse, disappear entirely. This new world is driven by changes in the retail competitive environment and in consumer behavior and expectations.

Evolving Industry Dynamics

- **Decades of e-commerce progress have shifted the retail equation.** Fewer customers today travel from store to store to fulfill their shopping needs. Instant access to all the world's goods via the internet and same-day delivery from e-tail and marketplace leaders such as Amazon, Walmart and Best Buy have fundamentally altered retail operations and customer expectations. Smartphones and mobile apps have made location-based commerce a reality as well, delivering aisles of shopping and contextual offers to consumers on the go, inviting customers to search for, discover and compare products from anywhere and enabling touch-and-go mobile payments.
- **In-store experiences are evolving as well.** While consumers haven't completely abandoned brick-and-mortar retail, their expectations have changed there as well. Frictionless, experiential, interactive product presentation and concierge services have upped the game. In-store integration with social networks and e-commerce operations have ushered in innovations such as in-store and curbside pickup, ship/deliver from store and return of digitally ordered goods. New customer behaviors – accelerated by the COVID-19 pandemic – made curbside pickup and home delivery from local merchants mainstream options. Consumer adoption of these innovations is just beginning, but points to a more omnichannel, integrated shopping future (See Figure 1).

Figure 1: The Future of Retail Is at the Starting Line – With More to Come



Q: How frequently do you expect to use each of the following digital experiences in the next 12 months?
Source: 451 Research's Voice of the Connected User Landscape, Disruptive Technologies Survey 2021

- **Consumer technology innovation marches onward.** The e-commerce evolution began with desktop PCs and web browsers in the 1990s. High-speed wireless networks, smartphones and mobile apps are further blurring the online and offline experience, creating always-online, 24/7 customers. And technology progress isn't slowing down. Emerging 5G consumer networks and devices offer even more speed and connectivity, enabling new immersive augmented and virtual reality (AR/VR) shopping experiences. 5G networks also support an endless array of IoT devices – in-store, shelf-level presence sensors, package-delivering drones, in-home intelligent speakers and other consumer devices – that serve as the foundation for the new normal of retail innovation.

Changing Consumer Behaviors and Heightened Expectations

In addition to changing industry dynamics, customer expectations have evolved dramatically as well.

- **Customers seek more personalized products and interactions.** Structural changes in the retail and e-tail sector have profoundly altered consumer expectations. For example, mass marketing and merchandising have yielded to more tailored, personalized interactions to give consumers what they want, how they want it, when they want it. Consumers have also become comfortable with trading their shopping and other behavioral histories for a more personalized touch.
- **Shopping is no longer just a transaction; it's an 'experience.'** Yes, there are still commodity products and scheduled purchases of staple goods. But even those routine buys are window-dressed using technology: Customers 'subscribe' online to frequently used items, buy dinner via fresh meal kits delivered weekly and join 'wine clubs' that learn their preferences and delight them with new finds. In-store experiences are just as unique; retailers are creating more inviting in-store environments, leveraging data about their customers to do more targeted merchandising, and using mobile app couponing and location-based services to spur hard-to-resist impulse purchases.

– **Consumers' retail experience expectations for speed, simplicity, ease of use and customer service are sky-high.** Customers simply will no longer tolerate an average – let alone poor — shopping experience. Retailers failing to meet these heightened expectations can face dire and immediate consequences:[1]

  - Eighty percent of consumers say they are likely to stop doing business with a vendor due to a poor customer experience.
  - Seventy percent of consumers say a poor-performing digital interaction (i.e., slow or unavailable) would make them somewhat or very likely to switch to a different brand or provider.

Retailers Are Working to Reinvent Themselves – But Early Results Are Mixed

For executives in the retail sector, this story of massive competitive and customer change is hardly new or surprising. The buzzwords are already there: c*onnected inventory, location-specific demand forecasting, omnichannel operations, 360-degree view of the customer, personalization, supply chain resiliency, immersive experiences.* Yet steering a retail operation in a new direction is a significant challenge. To implement such advances, retailers must better capture, analyze and then leverage the insights gained from the vast amounts of data they collect about their customers' behavior and activities. Not only this, but they must capture new and better data. The following are advances in tablestakes that are necessary to compete in this new 'retailscape':

– **Use real-time data analytics to gain better insights and a unified view of customer behavior and related inventory positions.** Understanding consumer wants and needs has always been job one for retailers. Today, more data is available to accomplish this than ever before – from the digital breadcrumbs of online shopping behavior to trails of in-store movements and purchases tracked via loyalty programs. Acquiring customer data 'haystacks' today isn't a problem; pulling it all together and finding the actionable 'needle' insights is. This valuable customer data must also be managed and protected via secure systems and clear data governance policies.

– **Optimize the customer journey across multiple channels.** Omnichannel operations enable retailers to seamlessly track and serve a single customer across multiple interaction points –online, mobile, in-store – and provide a better experience for that customer via integrated assortment, content, inventory, fulfillment and logistics processes. If they handle such operations well, omnichannel retailers can outflank their online and store-only rivals by better meeting customers where *they* want to shop via a retail operation that can serve every conceivable consumer channel – cutting cost-to-serve, increasing agility and improving the customer experience.

– **Enhance customer self-service through digital and mobile channels.** Retailers of the future must do more with less – that includes fewer brick-and-mortar locations and more limited retail staffs. Helping customers help themselves through digital and automation technology is paramount to next-gen retail success. Online, mobile app and automated kiosk/counter/locker interactions must not only be about selling but also about self-service. These interactions must enable customers to quickly and easily manage things such as product search and discovery; payment, check-out and delivery preferences; and post-sales support on their own – or in some cases with the help of an online community of fellow shoppers.

– **Reduce customer friction points and identify opportunities of influence.** With such high expectations and countless choices, retailing has become all about the moment: providing point-of-decision product or pricing information to avoid the abandoned shopping cart and turn a browser into a buyer. To do so, retailers must know where their potential buyers are and what they need to make a buying decision. They must also be able to drive the basket size, cross-sell and upsell based on buyers' specific needs, as well as have a path to reach out and touch them when the time is right.

1. 451 Research's Voice of the Connected User Landscape, Disruptive Technologies Survey 2021

This vision of the retail future is built on real-time customer, store and item data and insights. Retailers today are on the path to becoming more data-driven, but it's early, and the path forward is challenging:

- Just 12% of retailers say their customer experience decisions are primarily data-driven today.[2]
- Only 11% describe their customer experience processes as 'highly automated.'[3]
- And just 6% have consistent customer experience processes across departments and spanning customer channels from in-store to online.[4]

The reasons for this slow digital transformation are clear and not limited to the retail sector. Remaking decades- or, in some cases, centuries-old business processes doesn't happen without some resistance from staff and business leaders alike. Even with buy-in, changing or updating operational and business models is difficult. There must be strong commitment to the transformation that runs deep across all departments and activities. Finally, every technology-driven change comes with its own challenges: swapping out old IT infrastructure, systems and applications for new, hiring the right technology and business talent, purchasing the right technology/products, working with the best partners to help transform the business and supporting the IT stack in an altogether new and more data-driven way.

2. 451 Research's Voice of the Enterprise: Customer Experience & Commerce, Organizational Dynamics and Budgets
3. 451 Research's Voice of the Enterprise: Customer Experience & Commerce, Digital Maturity
4. 451 Research's Voice of the Enterprise: Customer Experience & Commerce, Digital Maturity

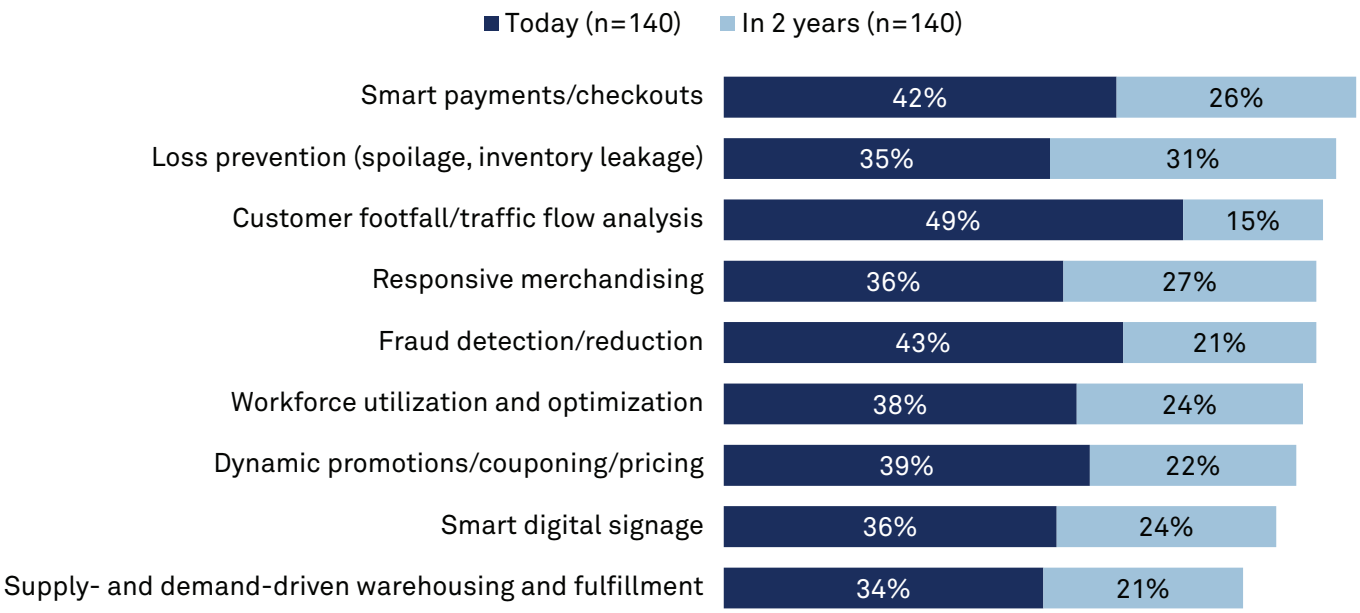
Reinventing Retail: The Path Forward

The challenges and opportunities facing today's retail sector are clear. And for many retailers – and their partners and suppliers – the path forward is becoming clear as well. The retail value chain is in the process of reimagining and reinventing itself, with a goal to meet new digital customer expectations and navigate today's omnichannel, digitally enabled competitive landscape.

Sitting at the center of that transformation is a range of critical retail use cases, many currently deployed or on the launch pad (see Figure 2). Taken together, these use cases require retailers to become more data- and analytics-driven. They bring together physical stores and digital and online experiences for customers. For retailers, they lay the foundation for the AI/ML-driven demand forecasting and logistics necessary to deliver an effective omnichannel approach, lowering operational costs and driving higher margins. These use cases have driven several critical advances:

- **More frictionless and personalized customer experiences.** Retailers need to make the discovery, shopping and buying experience as easy and seamless as possible. To foster that, 42% of retailers are already supporting smart payment and checkout options, growing to 68% in two years. That includes relatively simple point-of-sale upgrades supporting mobile app payments to more complex touchless checkout scenarios in which shoppers put items in their cart, and the price tally and payment processing happen almost magically as they walk out the door. Other elevated in-store interactions are available or on the way as well. For example, 61% of retailers plan to deliver on-the-go and just-in-time promotions to shoppers' mobile devices, while 60% expect to leverage data-fed digital smart signs for more targeted promotions and merchandising in-store.
- **Optimized retail operations driven by customer data and insights.** Enhanced customer interactions represent the 'front end' of retail digital transformation, but data-driven insights will remake the retail back office as well. There are several use cases (see Figure 2 below) that will help retailers reinvent their operations. Among them is data- and AI analytics-enabled 'footfall analysis,' the ability to track and optimize merchandising based on how shoppers move through a store or area; 64% of retailers expect to deploy this use case in the near future. Another is data-enabled loss prevention, including more accurate churn analysis, theft prevention and inventory optimization, which 66% of retailers have in their plans.

Figure 2: Data-Enabled Use Cases Drive Retail Transformation



Q. Which of the following use cases has your organization deployed today?
Q. Of those use cases you haven't deployed currently, which, if any, do you plan to deploy in the next two years?
Source: 451 Research's custom edge technology research for Dell Technologies

– **Improved collaboration with key retail value chain partners, from logistics providers to product makers.** Retailers are not only transforming their own operations; they are also taking advantage of similar data-enabled advances from logistics providers, product manufacturers and other value chain partners.[5] More agile retail capabilities such as just-in-time inventory and dynamic delivery services enabled by more collaborative partner relationships are critical to meet digital consumer demand and transform retailer back-end processes and financial flows. To enable those improvements, for instance, manufacturers are investing in more connected and data-driven production optimization (deployed or planned by 74% of product manufacturers) and insight-enhanced quality assurance programs (on the use case road map of 71% of manufacturers). Transportation and logistics providers, meanwhile, are deploying their own data-enabled use cases that will contribute to retail sector transformation, including improved inventory monitoring processes (deployed or planned by 68% of logistics providers) and more supply and demand-driven warehousing and fulfillment (planned by 55% of providers).

A picture of the future starts to become clear as we lay out the changes in retail sector competitive dynamics and consumer expectations and the efforts to meet those changes by evolving how retailers operate and interact with customers. Just as important as those business changes, however, is choosing the best technology approach to deliver on that vision – as quickly, affordably and nimbly as possible.

5. 451 Research's custom edge technology research for Dell Technologies

Edge Compute, 5G, IoT and AI/ML Play a Critical Enabling Role

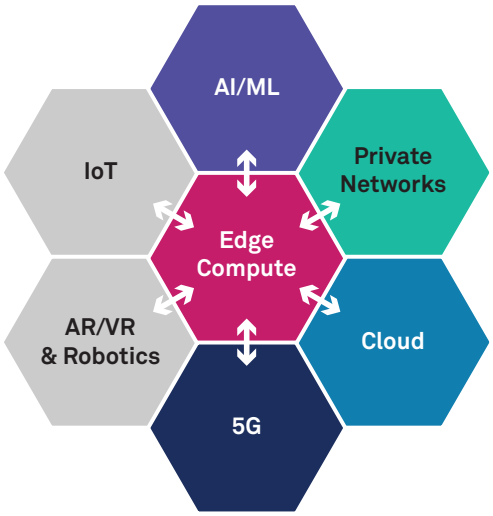
In much the same way that individual business sectors such as retail, manufacturing and logistics are transforming, so is the technology world that enables much of that change. On the consumer side, in-home broadband enabled desktop e-commerce, while smartphones, mobile apps and wireless networks allowed customers to cut the cord and shop anywhere. New technologies have impacted retail operations as well – most notably the emergence of the cloud, which allows enterprises to deploy centralized infrastructure and applications more dynamically and, in some cases, more affordably.

Yet another wave of technology change is underway: 5G networks have arrived. They are faster and more capable of handling connections from smartphones and countless additional IoT devices, and they enable new consumer applications such as real-time monitoring and action, as well as AR/VR shopping experiences. 5G's biggest impact, however, will be in supporting the type of enterprise use cases we detailed earlier, via capabilities such as ubiquitous machine-to-machine connectivity and ultra-low-latency application execution. At the same time, merchants have discovered that many of their most critical retail industry workloads require capabilities – such as high performance, low latency, endpoint security and support for data governance/sovereignty requirements – that current cloud-centric infrastructure options are challenged to fully meet. These workloads require computing infrastructure closer to where customer and store data is generated.

In response, enterprises are increasingly turning to edge computing – supported by high-speed, and soon-to-be-widespread, 5G wireless connectivity – to better enable their expanding digital ambitions. A more capable enterprise edge fulfills the always-on needs of new and emerging retail applications such as demand-driven inventory management, location-based marketing and contactless payment. It also supports the compute-intensive requirements of new technologies such as AI-driven customer behavioral analysis and more engaging AR/VR shopping experiences, as well as autonomous vehicle and drone-based deliveries.

In short, retailers are beginning to understand that to get the job done, they must integrate new technologies to help modernize IT infrastructure that supports the execution of critical workloads at the right venue, via the most capable infrastructure, in the most cost-effective manner (see Figure 3).

Figure 3: Impact of Edge Technologies on Retail Digital Transformation



How do edge + 5G enable retail digital transformation?

- Edge computing sits at the center of retail digital transformation
- 5G public and private networks provide critical connectivity – from edge to cloud
- Data flowing across these networks and systems powers IoT, augmented/virtual reality, robotics and AI/ML workloads

Source: 451 Research

Decisions about venue, infrastructure and cost are vitally important to digital transformation: indeed, 92% of enterprises somewhat or strongly agree that the location in which a digital application is deployed has a 'major impact' on their project success.[6]

More enterprises today – including in the retail sector – are counting on edge compute and 5G connectivity to fuel their digital ambitions:

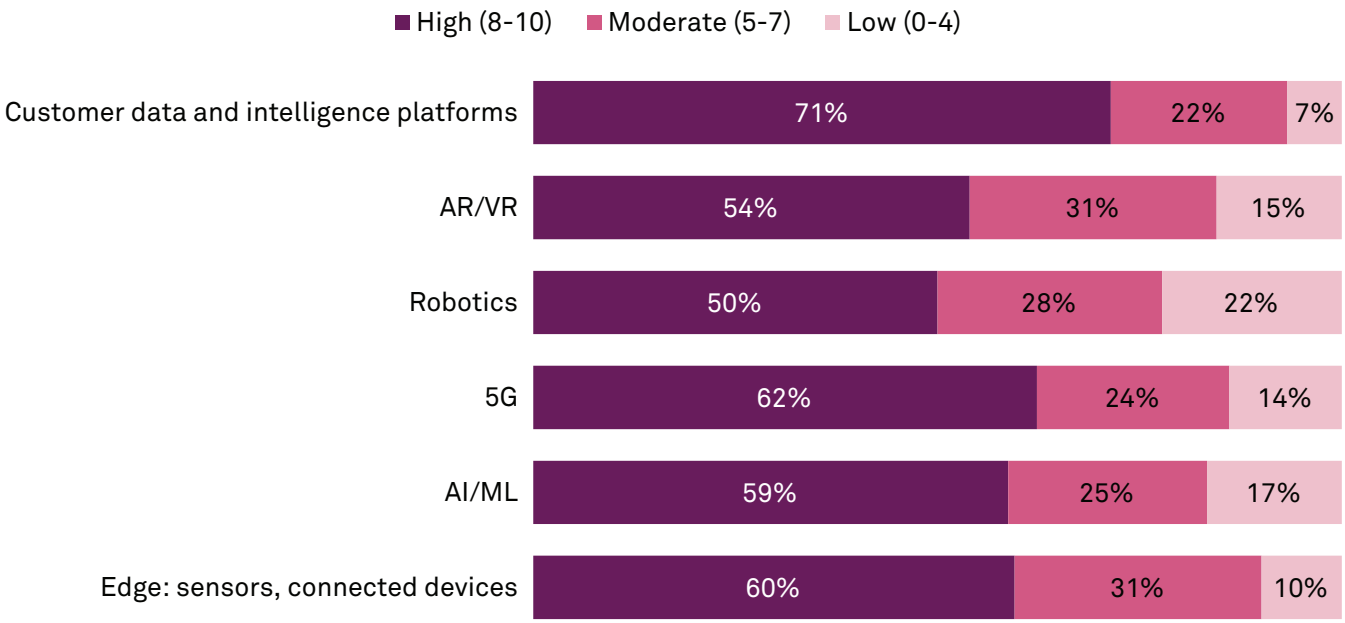
- Thirty-eight percent of retail enterprise infrastructure is already edge-based (deployed outside of core datacenters).[7]
- Seventy-seven percent of retailers say they will be increasing their edge infrastructure in the next two years, and 27% of those plan to increase it 'significantly.'[8]
- Sixty-three percent of retailers plan to augment their enterprise edge compute infrastructure with a private 5G network.[9]
- Retailers also stand to benefit significantly from consumer interest in 5G[10] networks and devices. Eighty-seven percent of consumers are already aware of some or all of the capabilities of 5G,[11] and 50% say they have already purchased or are likely to buy a 5G smartphone.[12]

6. 451 Research's Voice of the Enterprise: Internet of Things, Workloads & Key Projects 2021
7. 451 Research's custom edge technology research for Dell Technologies
8. 451 Research's custom edge technology research for Dell Technologies
9. 451 Research's custom edge technology research for Dell Technologies
10. 451 Research's custom edge technology research for Dell Technologies
11. 451 Research's Voice of the Connected User Landscape, Endpoints & IoT, Consumer Smartphone Trends (Leading Indicator), Satisfaction and Retention 2021
12. 451 Research's Voice of the Connected User Landscape, Endpoints & IoT, Consumer Smartphone Trends (Leading Indicator), Satisfaction and Retention 2021

While there is no universally optimal location to run enterprise workloads, undoubtedly some locations are better optimized for specific workloads, use cases or business processes. When it comes to determining the best execution venue, organizations need to account for a wide range of variables, including latency tolerance, data volumes, high-speed networking availability, security requirements, regulatory compliance, data sovereignty/locality considerations, IT support capabilities and operational control requirements. Many digital workloads simply may not run optimally – and thus fail to deliver mission-critical business outcomes – without a high-performance, low-latency connectivity and compute environment that can support real-time transactions, insights and actions.

Responsive, secure and agile edge infrastructure is an essential enabler to many of the other enabling technologies critical to the future of retail (see Figure 4). Customer data platforms, for example, work by aggregating data from an array of endpoints – most often out at the edge, near the customers themselves – and turning them into rapid-fire insights with the help of edge-deployed AI/ML-powered analytics. In addition, autonomous robots and vehicles – necessary to help automate retail warehouses and delivery systems – require a near-real-time feedback loop of data instructions best delivered by edge compute infrastructure.

Figure 4: Most 'Transformative' Emerging Retail Technologies, by Degree of Impact



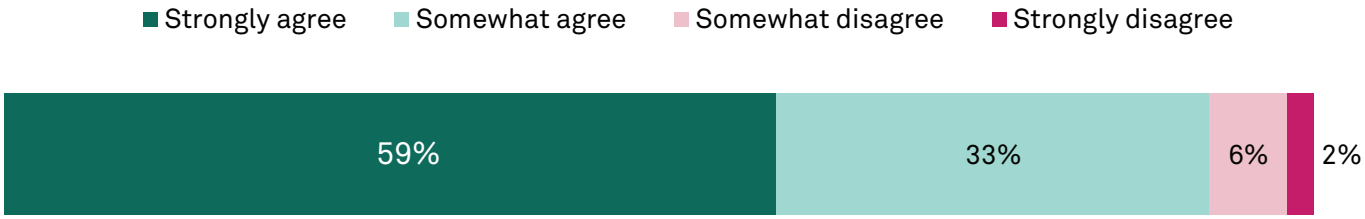
Q: Using a scale from 0-10, where 0 is 'not at all transformative' and 10 is 'highly transformative,' how transformative do you expect the following technologies to be for your business over the next three years?

Source: 451 Research's Voice of the Enterprise: Customer Experience & Commerce, Merchant Study

Making It Happen for Retail Business and IT Leaders

Decisions on where, when and how to best deploy technologies such as edge compute, 5G and AI/ML are not just theoretical technical decisions; they have a major impact on omnichannel business success. This is borne out by real-world deployments as enterprises across every sector learn from the successes and failures of their early digital efforts: 92% of enterprises say the location in which their data-driven applications are deployed – edge-to-cloud – has a MAJOR impact on their digital project success (see Figure 5). As we've seen, that includes a critical place for edge-related technologies: IoT sensors to collect consumer and in-store data; 5G networks to connect edge devices and machines; and edge storage, compute and AI/ML analytics capable of low-latency, high-performance execution of real-time retail applications and use cases.

Figure 5: Execution Venue Decisions Impact Digital Success

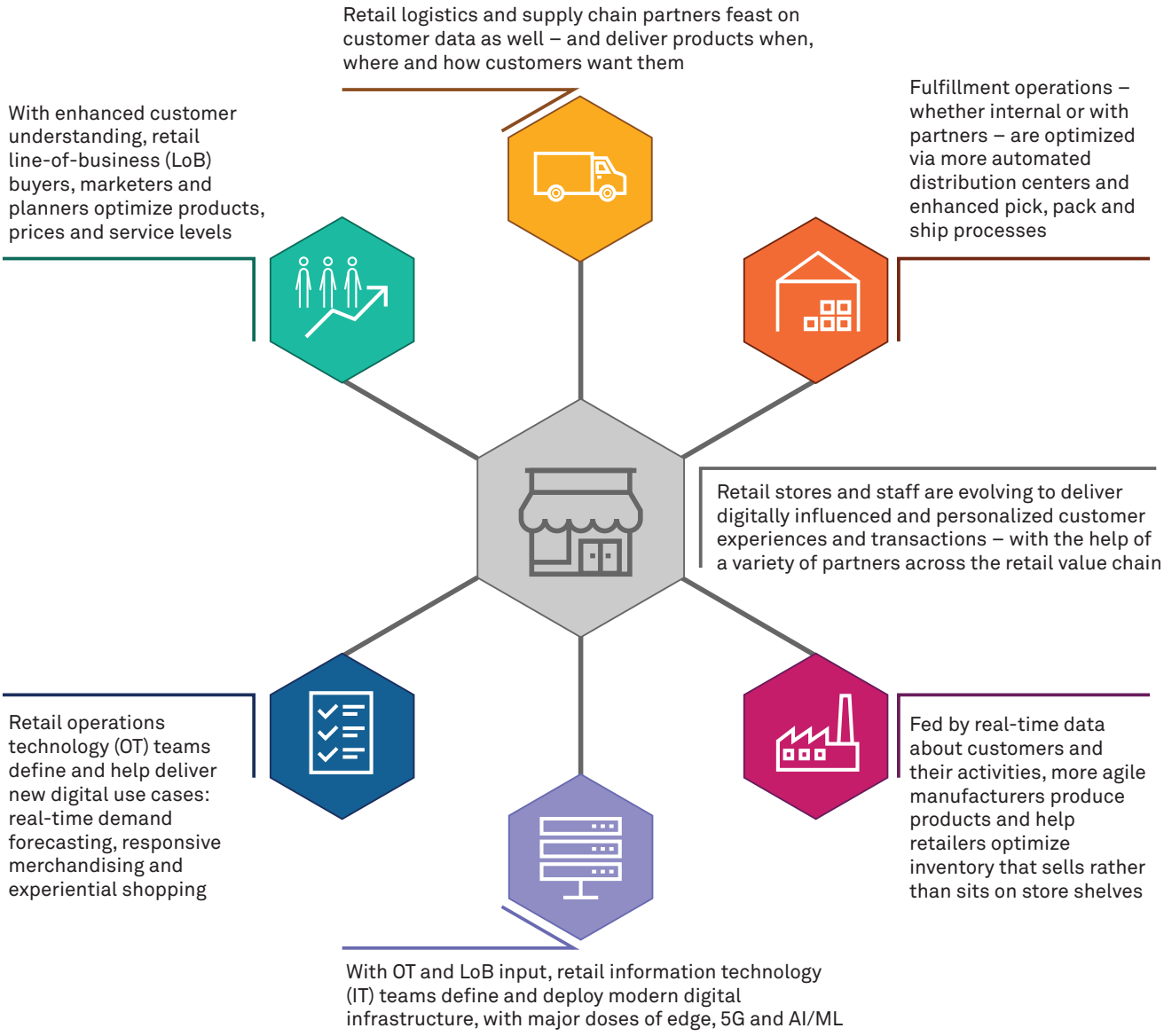


Q: For each of the following statements, please indicate whether you agree or disagree – My organization's IT department believes that the location in which our organization's IoT applications are deployed - edge, near-edge, cloud/core - has a major impact on our IoT project success.

Source: 451 Research's Voice of the Customer: IoT, Workloads and Key Projects Study 2021

These technology decisions and investments must also be made with understanding, input, assessment, alignment and buy-in across the organization. LoB units such as marketing and sales must make clear the data points needed to understand customer preferences, selling opportunities and inventory positions. Retail operations teams must take the lead in defining the applications, analytics and use cases – both legacy and altogether new – to deliver those insights. IT departments must understand both those business and operational requirements and help define and deploy an enabling infrastructure that can best support those needs with high levels of agility and performance (see Figure 6).

Figure 6: All of Retail's a Stage, and Every Actor Has a Significant Role



Source: 451 Research

Once again: These are not academic decisions, and each edge deployment is unique to the company, location and use case. Further, these decisions require deep levels of organizational alignment. It has proven true across enterprises of all shapes and sizes that IT and OT/LoB collaboration is critical to achieving digital goals:[13]

- Two years ago, 25% of enterprises reported a lack of collaboration between their IT and OT operations – with about half of those describing their relationship as 'active conflict' – hardly a recipe for digital success. Today, thanks to many hard-earned lessons, the percentage of enterprises fighting over digital control has shrunk to just 11% – a significant improvement. Meanwhile, 38% of enterprises say their IT and OT departments 'closely collaborate' from project inception to deliver a digital transformation best practice.

13. 451 Research's Voice of the Enterprise: Internet of Things, Organizational Dynamics

– Working toward such alignment pays major dividends in the real world. Firms with 'close' IT/OT collaboration are more likely to be in production with new digital projects than the average enterprise (48% vs. 37%) and, even more significantly, are more likely to achieve a 'very positive' digital project return on investment thanks to that internal cooperation (57% vs. 29%).

In the end, ownership of retail technology decisions – and in particular understanding of and advocacy for a robust retail IT/OT edge – requires IT, OT and LoB leaders to work together with a goal of delivering digital use cases fully aligning technology, business processes and business goals.

Action Steps

To ensure success at the edge, retail leaders in lines of business, operations or IT should:

– Be responsive to the changing world of retail – online and off – and the evolving requirements of increasingly demanding customers.

– Understand how technologies such as edge compute, 5G and AI can help transform retail omnichannel operations to succeed in this new world.

– Assess their current capabilities and gaps and work closely with counterparts across the business and with trusted technology provider partners to deploy the digital infrastructure necessary to differentiate their operations from less tech-savvy retail rivals, future-proofing their business success.

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