

Chapter – 5

Internet of Things (IoT) and Smart Retail Technologies for Connected Shopping Experiences

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Abstract: The fast progress of digital technologies has transformed the retail industry, creating highly connected, data-driven, and customer-centric shopping environments. Among these technologies, the Internet of Things (IoT) has emerged as a key enabler of smart retail by facilitating real-time communication among devices, products, customers, and business systems. This chapter explores the role of IoT and smart retail technologies in developing connected shopping experiences that enhance operational efficiency, supply chain performance, and customer engagement. The chapter begins by examining the evolution of retail technologies and the fundamental concepts, architecture, and infrastructure of IoT in retail environments. It discusses essential IoT components, including sensors, RFID systems, smart tags, beacons, communication networks, cloud computing, and edge computing technologies that support intelligent retail ecosystems. The chapter further investigates the application of IoT in smart inventory management and supply chain optimization through RFID-based tracking, smart shelves, automated stock monitoring, predictive inventory management, warehouse automation, and supply chain traceability. It also highlights how connected technologies contribute to personalized customer experiences through smart shopping carts, location-based services, beacon technologies, automated checkout systems, and omnichannel integration.

Keywords: *Internet of Things (IoT); Smart Retail; Connected Shopping Experiences; Retail Digital Transformation; RFID Technology; Smart Inventory Management; Supply Chain Optimization; Smart Shelves*

I. INTRODUCTION

The retail industry has undergone significant transformation over the past few decades, driven by rapid advancements in digital technologies and changing consumer expectations. Traditional retail operations, which primarily relied on manual inventory management, physical stores, and conventional customer service approaches, have evolved into highly connected and data-driven ecosystems. Among the technologies contributing to this transformation, the Internet of Things (IoT) has emerged as one of the most influential innovations, enabling retailers to

create intelligent shopping environments, optimize operational efficiency, and deliver highly personalized customer experiences. IoT refers to a network of interconnected devices, sensors, software applications, and communication systems that collect, exchange, and analyze data in real time. In retail environments, IoT technologies facilitate seamless communication among products, shelves, stores, customers, and supply chain systems, thereby enabling smarter decision-making and enhanced service delivery. As retail organizations increasingly embrace digital transformation strategies, IoT serves as a critical enabler of connected shopping experiences, bridging the gap between physical and digital retail channels while supporting omnichannel commerce initiatives.

1.1 Evolution of Retail Technologies

The evolution of retail technologies reflects the industry's continuous pursuit of operational efficiency and customer satisfaction. Early retail systems were characterized by manual processes, paper-based inventory records, and cash transactions. The introduction of barcode technology in the 1970s revolutionized inventory tracking and point-of-sale operations by enabling automated product identification and faster checkout processes. Subsequently, Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) platforms, and e-commerce websites transformed retail operations by facilitating centralized data management and online transactions. The emergence of mobile commerce, cloud computing, social media platforms, and advanced analytics further accelerated retail innovation by providing new avenues for customer engagement and business intelligence. Today, IoT represents the next phase in retail evolution, enabling real-time connectivity among devices and systems. Smart shelves, RFID-enabled inventory management, connected shopping carts, and sensor-driven customer analytics are examples of technologies that have transformed traditional retail stores into intelligent environments capable of delivering seamless and personalized shopping experiences.

1.2 Concept and Architecture of the Internet of Things

The Internet of Things is a technological paradigm that enables physical objects to communicate and exchange information through the internet and other communication networks. IoT systems consist of interconnected devices equipped with sensors, actuators, processors, and communication modules that collect and transmit data for analysis and decision-making. The architecture of IoT generally comprises four primary layers: the perception layer, network layer, processing layer, and application layer. The perception layer includes sensors and devices responsible for capturing data from the physical environment. The network layer facilitates communication between devices and centralized systems through wired or wireless technologies. The processing layer involves cloud computing platforms, edge computing systems, and data analytics engines that process and analyze collected information. Finally, the application layer delivers actionable insights and services to end users through various retail applications. In retail environments, this

architecture supports real-time inventory monitoring, customer behavior analysis, predictive maintenance, and personalized marketing initiatives. By integrating physical retail assets with digital platforms, IoT architecture creates a connected ecosystem capable of generating valuable business intelligence and enhancing customer experiences.

1.3 Connected Retail Ecosystems

Connected retail ecosystems represent a comprehensive integration of technologies, processes, stakeholders, and data sources within the retail value chain. These ecosystems enable seamless interactions among retailers, suppliers, logistics providers, customers, and technology platforms. IoT plays a central role in establishing connectivity across these entities by facilitating continuous data exchange and real-time visibility into operations. In a connected retail ecosystem, smart shelves communicate inventory levels to warehouse management systems, RFID-enabled products transmit location information throughout the supply chain, and mobile applications interact with in-store beacons to provide personalized promotions to customers. The ecosystem extends beyond individual stores to encompass online platforms, distribution centers, transportation networks, and customer service channels. Through the integration of IoT devices, cloud platforms, artificial intelligence, and analytics systems, retailers can achieve end-to-end visibility and coordination across all operational activities. This interconnected environment enables faster response to market demands, improved inventory accuracy, enhanced customer engagement, and more efficient resource utilization.

1.4 Role of IoT in Digital Transformation of Retail

Digital transformation in retail involves the strategic adoption of digital technologies to improve business processes, customer experiences, and organizational performance. IoT serves as a foundational technology in this transformation by enabling retailers to collect and utilize real-time data from various touchpoints across the customer journey. Through IoT-enabled systems, retailers gain deeper insights into customer preferences, shopping behaviors, and operational performance. Smart sensors and connected devices continuously monitor store environments, inventory levels, customer movements, and equipment conditions, generating valuable data that supports evidence-based decision-making. IoT also facilitates automation of routine tasks, such as inventory replenishment, energy management, and equipment maintenance, thereby reducing operational costs and improving efficiency. Furthermore, IoT supports omnichannel retail strategies by connecting physical stores with online and mobile channels, creating a unified and consistent customer experience. As retail organizations seek to remain competitive in an increasingly digital marketplace, IoT-driven transformation initiatives have become essential for enhancing agility, innovation, and customer-centricity.

1.5 Benefits and Challenges of IoT Adoption in Retail

The adoption of IoT technologies offers numerous benefits for retailers, including improved inventory accuracy, enhanced customer experiences, optimized supply chain operations, and increased operational efficiency. Real-time monitoring capabilities enable retailers to maintain accurate inventory records, reduce stockouts, and minimize overstock situations. IoT-based customer analytics provide valuable insights into shopping patterns, enabling personalized marketing campaigns and targeted product recommendations. Additionally, predictive maintenance systems help reduce equipment downtime and maintenance costs by identifying potential issues before they result in failures. Despite these advantages, IoT implementation presents several challenges. Data security and privacy concerns remain significant issues, as connected devices generate large volumes of sensitive customer and operational data. Integration complexity, interoperability limitations, high implementation costs, and the need for specialized technical expertise can also hinder adoption efforts. Furthermore, managing and analyzing massive amounts of IoT-generated data requires advanced infrastructure and analytics capabilities. Addressing these challenges through robust governance frameworks, cybersecurity measures, and strategic technology investments is essential for realizing the full potential of IoT in retail environments.

II. IOT INFRASTRUCTURE AND SMART RETAIL ARCHITECTURE

The successful implementation of IoT in retail depends on a robust infrastructure that supports data collection, communication, processing, and intelligent decision-making. Smart retail architecture comprises interconnected hardware, software, communication networks, and analytical platforms that work together to create an intelligent and responsive retail environment. This architecture enables retailers to monitor operations in real time, automate processes, and deliver personalized customer experiences. The increasing complexity of retail operations and the growing volume of generated data require scalable and flexible infrastructure capable of supporting diverse IoT applications. From inventory tracking and customer engagement to supply chain optimization and predictive analytics, smart retail architecture provides the technological foundation necessary for digital transformation initiatives. Understanding the components and technologies that constitute IoT infrastructure is therefore critical for designing efficient and sustainable connected retail ecosystems.

2.1 Components of IoT Systems

IoT systems are composed of multiple interconnected components that collectively facilitate data acquisition, communication, processing, and action. These components form the foundation of smart retail environments and enable real-time visibility into operational activities.

- **Sensors and Actuators:** Sensors are fundamental elements of IoT systems that collect data from the physical environment and convert it into digital information. In retail settings, sensors monitor temperature, humidity, product movement, customer traffic, shelf occupancy, and equipment performance. For example, temperature sensors ensure proper storage conditions for perishable goods, while motion sensors analyze customer movement patterns within stores. Actuators complement sensors by performing physical actions based on received instructions or analytical outcomes. Examples include automated lighting systems, smart doors, digital signage displays, and robotic inventory management systems. Together, sensors and actuators enable intelligent automation and responsive retail operations.
- **RFID Technologies:** Radio Frequency Identification (RFID) technology has become a cornerstone of modern retail IoT implementations. RFID systems use electromagnetic fields to automatically identify and track tagged products throughout the supply chain and retail environment. Unlike traditional barcodes, RFID tags can be read without direct line-of-sight, enabling faster and more accurate inventory management. Retailers utilize RFID technologies for stock monitoring, theft prevention, supply chain visibility, and automated checkout processes. The ability to track products in real time significantly improves inventory accuracy and operational efficiency.
- **Smart Tags and Beacons:** Smart tags and beacons provide advanced capabilities for location tracking, customer engagement, and asset monitoring. Smart tags incorporate sensors and communication modules that transmit information regarding product conditions and locations. Bluetooth beacons, on the other hand, communicate with customer smartphones and mobile applications to deliver location-specific notifications, promotions, and personalized recommendations. These technologies enhance customer engagement while providing retailers with valuable insights into shopper behavior and store navigation patterns.
- **Edge Devices and Gateways:** Edge devices and gateways serve as intermediaries between IoT sensors and centralized processing platforms. These devices collect data from multiple sensors, perform preliminary processing, and transmit relevant information to cloud systems for further analysis. Edge computing capabilities enable real-time decision-making by processing data closer to its source, thereby reducing latency and network congestion. In retail environments, edge devices support applications such as real-time inventory monitoring, video analytics, and automated customer service systems.

2.2 Communication Technologies

Communication technologies are essential for enabling seamless data exchange among IoT devices, cloud platforms, and retail applications. Different

communication protocols are selected based on factors such as range, power consumption, bandwidth requirements, and deployment environments.



Figure 1: IoT Infrastructure and Smart Retail Architecture

- **Wi-Fi** : Wi-Fi is one of the most widely used communication technologies in retail IoT implementations. It provides high-speed wireless connectivity for devices, applications, and customer services. Retailers use Wi-Fi networks to

support smart shelves, digital signage, mobile applications, and customer analytics systems. Wi-Fi infrastructure also facilitates location tracking and in-store customer engagement initiatives.

- **Bluetooth Low Energy (BLE):** Bluetooth Low Energy (BLE) is a power-efficient wireless communication technology designed for short-range data transmission. BLE is commonly used in retail beacons, wearable devices, and location-based marketing applications. Its low power consumption makes it suitable for battery-operated devices that require extended operational lifespans.
- **Zigbee:** Zigbee is a low-power wireless communication protocol specifically designed for IoT applications. It supports mesh networking, allowing devices to communicate with one another over extended distances through intermediary nodes. Zigbee is frequently employed in smart lighting systems, environmental monitoring applications, and automated retail infrastructure.
- **5G Networks:** Fifth-generation (5G) wireless networks offer unprecedented levels of speed, reliability, and connectivity. The deployment of 5G technology is expected to significantly enhance retail IoT capabilities by enabling real-time data transmission, advanced video analytics, augmented reality experiences, and large-scale device connectivity. 5G supports the growing demand for bandwidth-intensive retail applications and facilitates the development of highly responsive smart retail ecosystems.
- **LPWAN Technologies:** Low-Power Wide-Area Network (LPWAN) technologies such as LoRaWAN and NB-IoT provide long-range communication capabilities with minimal power consumption. These technologies are particularly useful for asset tracking, environmental monitoring, and remote retail operations where traditional communication networks may be impractical. LPWAN solutions enable scalable IoT deployments while maintaining cost efficiency.

2.3 Cloud and Edge Computing for Retail IoT

Cloud computing and edge computing serve as critical enablers of IoT-based retail systems. Cloud platforms provide scalable storage, processing power, and advanced analytics capabilities for managing large volumes of IoT-generated data. Retail organizations utilize cloud environments to integrate information from multiple stores, supply chains, and customer touchpoints into centralized data repositories. Cloud-based analytics facilitate demand forecasting, customer segmentation, inventory optimization, and strategic decision-making. Edge computing complements cloud computing by processing data closer to its source. Rather than transmitting all collected data to centralized servers, edge devices perform preliminary analysis locally, reducing latency and bandwidth requirements. This capability is particularly valuable for time-sensitive retail applications such as automated checkout systems, video surveillance analytics, and real-time inventory management. The combination of cloud and edge computing creates a hybrid architecture that balances scalability, efficiency, and responsiveness in smart retail environments.

2.4 Data Collection, Processing, and Analytics Frameworks

Data serves as the foundation of IoT-enabled retail operations. Smart retail systems continuously collect information from sensors, RFID readers, customer devices, transactional systems, and operational equipment. Effective data management requires comprehensive frameworks capable of supporting data acquisition, storage, integration, processing, and analysis. Modern analytics platforms employ machine learning algorithms, predictive modeling techniques, and artificial intelligence tools to extract actionable insights from collected data. Retail analytics frameworks support numerous applications, including customer behavior analysis, personalized marketing, demand forecasting, inventory optimization, fraud detection, and operational performance monitoring. Real-time analytics capabilities enable retailers to respond quickly to changing conditions, while historical data analysis supports long-term strategic planning. By leveraging advanced analytics frameworks, retailers can transform raw IoT data into valuable business intelligence that enhances competitiveness and customer satisfaction.

2.5 Security and Privacy Considerations

As IoT deployments expand across retail environments, security and privacy considerations have become increasingly important. Connected devices generate vast amounts of sensitive information, including customer data, transaction records, inventory details, and operational metrics. Unauthorized access to this information can result in financial losses, reputational damage, and regulatory penalties. Consequently, retailers must implement comprehensive cybersecurity strategies to protect IoT ecosystems. Security measures include device authentication, encryption protocols, network segmentation, intrusion detection systems, and continuous monitoring mechanisms. Regular software updates and vulnerability assessments are essential for mitigating emerging threats. In addition to security concerns, retailers must address privacy issues associated with collecting and analyzing customer data. Compliance with data protection regulations, transparent data collection practices, and informed customer consent are critical components of responsible IoT governance. By prioritizing security and privacy, retailers can build consumer trust while ensuring the sustainable growth of connected retail technologies.

III. SMART INVENTORY MANAGEMENT AND SUPPLY CHAIN OPTIMIZATION

The rapid growth of connected technologies has significantly transformed inventory management and supply chain operations within the retail sector. Traditional inventory management approaches often relied on manual stock counts, periodic audits, and reactive replenishment strategies, leading to inefficiencies, stock discrepancies, and delayed responses to market demands. The integration of the Internet of Things (IoT) into retail operations has introduced a new era of intelligent inventory management characterized by real-time monitoring, predictive analytics,

automation, and enhanced supply chain visibility. Through the deployment of connected sensors, RFID systems, smart shelves, and advanced analytics platforms, retailers can continuously track products, monitor inventory levels, optimize warehouse operations, and ensure seamless product movement across the supply chain. These capabilities enable organizations to reduce operational costs, improve inventory accuracy, enhance customer satisfaction, and achieve greater agility in responding to dynamic market conditions. As retail environments become increasingly complex and interconnected, smart inventory management and supply chain optimization have emerged as critical components of digital transformation strategies.

3.1 RFID-Based Inventory Tracking

Radio Frequency Identification (RFID) technology has become one of the most widely adopted IoT solutions for inventory management in modern retail environments. RFID systems utilize radio waves to automatically identify and track products equipped with electronic tags containing unique identification information. Unlike traditional barcode systems, RFID tags do not require direct line-of-sight scanning, enabling multiple items to be read simultaneously and significantly improving operational efficiency. RFID readers installed throughout stores, warehouses, and distribution centers continuously collect information about product locations and movements, providing retailers with accurate and up-to-date inventory data.

The implementation of RFID-based inventory tracking offers numerous benefits, including improved stock accuracy, reduced labor requirements, enhanced theft prevention, and streamlined replenishment processes. Retailers can monitor inventory levels in real time, quickly identify misplaced items, and reduce stock discrepancies that often result from manual inventory management practices. Additionally, RFID technology supports end-to-end product tracking throughout the supply chain, enabling retailers to gain greater visibility into product availability and movement. This capability is particularly valuable for managing large inventories, reducing stockouts, and ensuring timely product replenishment. As RFID technology continues to evolve, its integration with cloud computing and advanced analytics platforms further enhances inventory intelligence and operational decision-making.

3.2 Smart Shelves and Automated Stock Monitoring

Smart shelves represent a significant advancement in retail inventory management by incorporating sensors, weight detection mechanisms, RFID readers, and communication technologies directly into shelving units. These intelligent systems continuously monitor product availability, stock levels, and shelf conditions, enabling retailers to maintain accurate inventory records and optimize merchandising strategies. When products are removed or replenished, smart shelves

automatically update inventory databases and generate alerts when stock levels fall below predefined thresholds.

Automated stock monitoring through smart shelves reduces the need for manual shelf inspections and inventory audits, allowing employees to focus on higher-value customer service activities. Furthermore, smart shelves provide valuable insights into customer purchasing behaviors by tracking product interactions and movement patterns. Retailers can analyze shelf-level data to identify popular products, optimize product placement, and improve store layouts. In addition to enhancing operational efficiency, smart shelves contribute to improved customer satisfaction by minimizing out-of-stock situations and ensuring product availability. As IoT technologies continue to mature, smart shelves are expected to play an increasingly important role in autonomous retail environments and intelligent store management systems.

3.3 Real-Time Inventory Visibility

Real-time inventory visibility is a fundamental objective of modern retail operations and a key benefit of IoT-enabled inventory management systems. By integrating sensors, RFID technologies, cloud platforms, and analytics tools, retailers can gain continuous access to accurate inventory information across stores, warehouses, and distribution centers. This real-time visibility enables organizations to monitor stock levels, product locations, and inventory movements at any given moment, facilitating faster and more informed decision-making.

The availability of real-time inventory data supports numerous retail functions, including demand forecasting, replenishment planning, order fulfillment, and customer service. For example, retailers can immediately identify inventory shortages and initiate replenishment actions before stockouts occur. Similarly, omnichannel retail strategies benefit significantly from real-time inventory visibility, as customers can access accurate information regarding product availability across multiple sales channels. This capability improves order accuracy, enhances customer experiences, and supports services such as buy-online-pickup-in-store (BOPIS) and ship-from-store fulfillment models. By providing comprehensive visibility into inventory assets, IoT technologies help retailers achieve greater operational efficiency and responsiveness in increasingly competitive markets.

3.4 Predictive Inventory Management

Predictive inventory management leverages IoT-generated data, artificial intelligence, machine learning algorithms, and advanced analytics techniques to forecast future inventory requirements and optimize stock levels. Traditional inventory management approaches often rely on historical sales data and manual forecasting methods, which may not adequately account for changing market conditions, seasonal trends, or unexpected demand fluctuations. Predictive inventory management addresses these limitations by continuously analyzing real-

time data from multiple sources, including sales transactions, customer behavior patterns, environmental conditions, and supply chain activities. Machine learning models can identify complex demand patterns and generate accurate forecasts that enable retailers to proactively adjust inventory strategies. This predictive capability reduces the likelihood of stockouts, minimizes excess inventory, and improves overall inventory turnover rates. Additionally, predictive inventory management supports dynamic replenishment processes by automatically generating purchase orders and inventory recommendations based on anticipated demand. As retailers increasingly adopt data-driven decision-making practices, predictive inventory management has become an essential tool for improving operational efficiency, reducing costs, and enhancing customer satisfaction.

3.5 IoT-Enabled Warehouse Automation

Warehouses play a critical role in retail supply chains by facilitating the storage, handling, and distribution of products. The integration of IoT technologies into warehouse operations has led to significant improvements in efficiency, accuracy, and productivity through automation and real-time monitoring. IoT-enabled warehouse automation involves the deployment of connected sensors, autonomous mobile robots, automated guided vehicles (AGVs), smart conveyor systems, and intelligent inventory management platforms. These technologies enable warehouses to automate routine tasks such as product identification, inventory tracking, order picking, sorting, packaging, and shipment preparation. Sensors continuously monitor environmental conditions, equipment performance, and inventory movements, providing real-time visibility into warehouse operations. Autonomous robots can navigate warehouse environments independently, transport goods between locations, and assist with order fulfillment activities. Furthermore, predictive maintenance systems monitor equipment health and identify potential issues before failures occur, reducing downtime and maintenance costs. By enhancing operational efficiency and reducing human error, IoT-enabled warehouse automation supports faster order processing, improved inventory accuracy, and greater supply chain responsiveness.

3.6 Supply Chain Transparency and Traceability

Supply chain transparency and traceability have become increasingly important in modern retail environments due to growing consumer expectations, regulatory requirements, and sustainability concerns. IoT technologies enable comprehensive visibility into product movements and conditions throughout the supply chain, from manufacturing facilities and distribution centers to retail stores and end consumers. Through the deployment of RFID tags, GPS tracking devices, environmental sensors, and cloud-based monitoring platforms, retailers can continuously monitor the location, status, and condition of products in transit.



Figure 2: IoT-Enabled Smart Inventory and Supply Chain Optimization Framework

Enhanced traceability capabilities allow organizations to verify product authenticity, monitor compliance with quality standards, and respond quickly to supply chain disruptions. For example, temperature-sensitive products such as food and pharmaceuticals can be continuously monitored to ensure compliance with storage and transportation requirements. In the event of product recalls or quality issues, retailers can rapidly identify affected products and trace their movement throughout the supply chain. Moreover, supply chain transparency supports sustainability initiatives by enabling organizations to monitor resource utilization, reduce waste, and ensure ethical sourcing practices. As consumers increasingly demand greater

visibility into product origins and sustainability practices, IoT-enabled traceability systems have become a valuable competitive differentiator for retail organizations.

IV. CONNECTED CUSTOMER EXPERIENCES AND SMART SHOPPING

The retail industry is increasingly focused on delivering personalized, convenient, and engaging customer experiences across multiple channels and touchpoints. Modern consumers expect seamless interactions that integrate digital and physical shopping environments while providing customized services tailored to their preferences and behaviors. IoT technologies have emerged as key enablers of connected customer experiences by facilitating real-time communication between retailers, products, devices, and consumers. Through the deployment of smart shopping technologies, location-based services, automated checkout systems, and omnichannel platforms, retailers can create intelligent shopping environments that enhance convenience, improve customer satisfaction, and strengthen brand loyalty. The integration of IoT into customer-facing retail operations not only improves shopping experiences but also provides valuable data that supports personalized marketing strategies and customer engagement initiatives.

4.1 Personalized Shopping Experiences

Personalization has become a central component of modern retail strategies as organizations seek to differentiate themselves in increasingly competitive markets. IoT technologies enable retailers to collect and analyze data from multiple customer touchpoints, including mobile applications, in-store sensors, loyalty programs, and online platforms. By leveraging this information, retailers can develop comprehensive customer profiles that support personalized recommendations, targeted promotions, and customized shopping experiences.

Advanced analytics and artificial intelligence systems process customer behavior data to identify preferences, purchasing patterns, and engagement trends. Based on these insights, retailers can deliver relevant product suggestions, personalized discounts, and individualized marketing messages through various communication channels. Personalized shopping experiences not only increase customer satisfaction but also contribute to higher conversion rates, greater customer retention, and enhanced brand loyalty. As consumers continue to demand more tailored interactions, IoT-driven personalization is expected to remain a critical element of retail innovation.

4.2 Smart Shopping Carts and Smart Baskets

Smart shopping carts and smart baskets represent innovative applications of IoT technology designed to improve convenience and efficiency during in-store shopping experiences. These intelligent devices are equipped with sensors, RFID readers, touchscreen interfaces, and wireless communication capabilities that enable real-time product identification, inventory updates, and customer assistance.

As customers place products into smart carts or baskets, embedded technologies automatically recognize selected items and update virtual shopping lists. Some systems provide product information, promotional offers, nutritional details, and personalized recommendations directly through integrated displays or connected mobile applications. Additionally, smart shopping carts can guide customers through stores using digital maps and optimized shopping routes. By streamlining product selection, reducing checkout times, and enhancing customer engagement, smart shopping technologies contribute to more efficient and enjoyable retail experiences.

4.3 Location-Based Services and Indoor Navigation

Location-based services (LBS) utilize IoT technologies, mobile devices, and positioning systems to provide context-aware services based on customers' physical locations. In retail environments, location-based services enable retailers to deliver personalized content, promotional offers, and navigation assistance while customers are inside stores. Through the integration of beacons, Wi-Fi networks, Bluetooth technologies, and mobile applications, retailers can accurately determine customer locations and provide relevant information in real time.

Indoor navigation systems help customers locate products, departments, and services within large retail spaces. These systems improve shopping convenience by reducing search times and enhancing store accessibility. Retailers also benefit from location analytics that provide insights into customer movement patterns, dwell times, and traffic flows. Such information supports store layout optimization, product placement strategies, and customer engagement initiatives. As retail spaces become increasingly digitized, location-based services are expected to play a vital role in enhancing customer experiences and operational intelligence.

4.4 Beacon Technology for Customer Engagement

Beacon technology has emerged as a powerful tool for delivering personalized and context-sensitive customer interactions within retail environments. Beacons are small wireless devices that use Bluetooth Low Energy (BLE) technology to communicate with nearby smartphones and mobile applications. When customers enter a beacon-enabled area, retailers can send targeted notifications, promotional offers, loyalty rewards, and product recommendations directly to their mobile devices.

Beacon technology enables retailers to engage customers at specific locations within stores, increasing the relevance and effectiveness of marketing communications. For example, customers approaching a particular product category may receive discount offers or product information related to their interests. Additionally, beacons provide valuable analytics regarding customer movement patterns and engagement levels. These insights help retailers refine marketing strategies, optimize store layouts, and improve customer experiences. The ability to deliver personalized

interactions in real time makes beacon technology a valuable component of connected retail ecosystems.

4.5 Contactless and Automated Checkout Systems

The demand for faster and more convenient shopping experiences has accelerated the adoption of contactless and automated checkout technologies. IoT-enabled checkout systems utilize RFID tags, computer vision technologies, sensors, mobile payment platforms, and artificial intelligence to streamline transaction processes and reduce customer waiting times. Contactless payment solutions allow customers to complete transactions using smartphones, wearable devices, and digital wallets without physical contact. Automated checkout systems further enhance convenience by eliminating traditional cashier interactions. In cashier-less retail environments, sensors and computer vision systems automatically identify products selected by customers and process payments when they leave the store. These technologies improve operational efficiency, reduce labor requirements, and enhance customer satisfaction by minimizing checkout friction. As consumer preferences continue to shift toward convenience and speed, contactless and automated checkout systems are becoming increasingly prevalent in modern retail environments.

4.6 Omnichannel Integration through IoT

Omnichannel retailing seeks to provide customers with seamless and consistent experiences across physical stores, e-commerce platforms, mobile applications, social media channels, and customer service touchpoints. IoT technologies play a critical role in enabling omnichannel integration by connecting disparate systems and facilitating real-time data sharing across channels. Through IoT-enabled infrastructure, retailers can synchronize inventory information, customer profiles, order statuses, and promotional activities across the entire retail ecosystem. This integration supports various omnichannel services, including click-and-collect, buy-online-pickup-in-store (BOPIS), ship-from-store fulfillment, and cross-channel customer engagement. Customers benefit from consistent experiences regardless of how they interact with a retailer, while organizations gain greater visibility into customer journeys and operational performance. Furthermore, IoT-generated data supports advanced analytics that enable retailers to optimize customer experiences, improve service quality, and develop more effective marketing strategies. As retail continues to evolve toward highly connected and customer-centric business models, IoT-driven omnichannel integration will remain a key driver of innovation and competitive advantage.

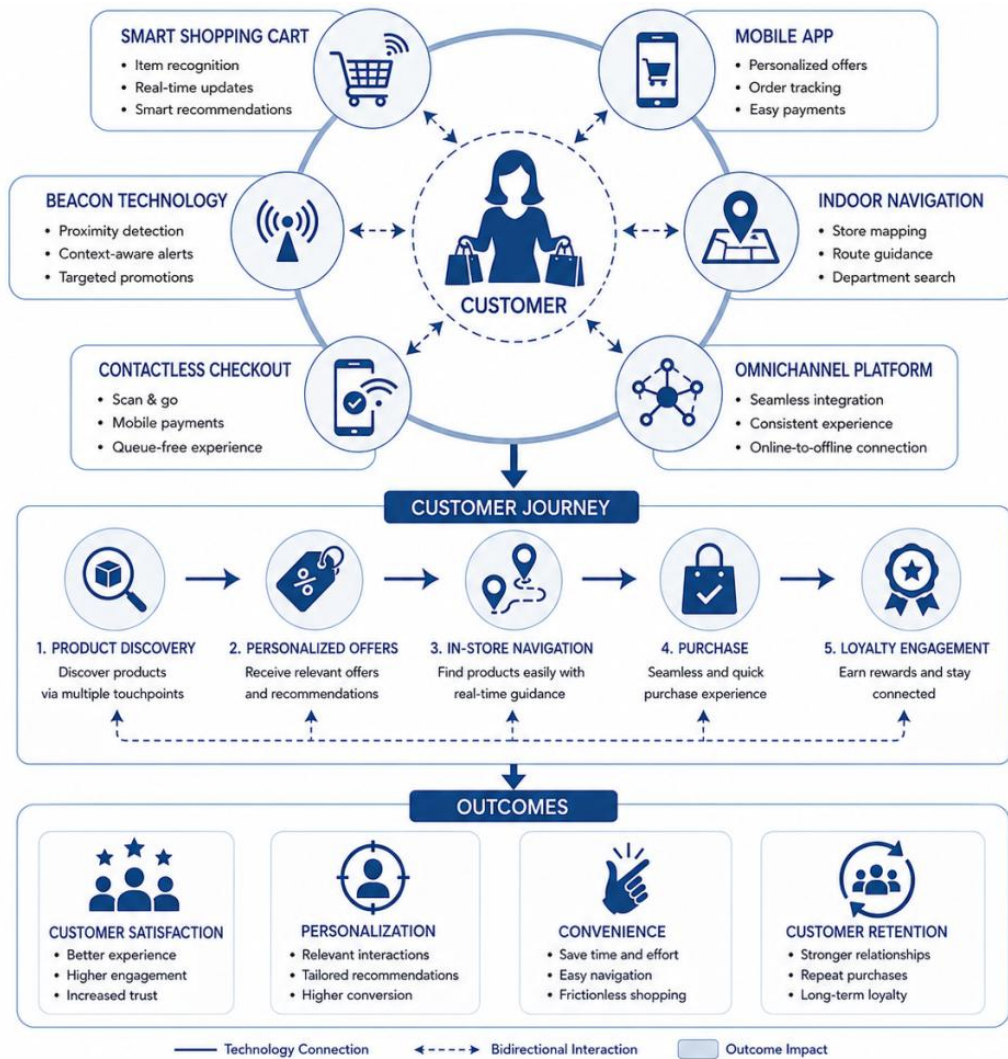


Figure 3: Connected Customer Experience and Smart Shopping Ecosystem

V. ARTIFICIAL INTELLIGENCE, ANALYTICS, AND SMART RETAIL DECISION-MAKING

The convergence of the Internet of Things (IoT), Artificial Intelligence (AI), and advanced analytics has fundamentally transformed retail decision-making processes. Modern retail environments generate enormous volumes of data through connected devices, customer interactions, supply chain operations, and digital platforms. While IoT technologies facilitate data collection and connectivity, AI and analytics provide the intelligence necessary to transform raw data into actionable insights. This integration enables retailers to make faster, more accurate, and data-driven decisions across inventory management, customer engagement, pricing strategies, and operational planning. Smart retail decision-making relies on advanced computational models that can identify patterns, predict future trends, automate routine decisions, and optimize business processes in real time. As competition intensifies and customer expectations continue to evolve, AI-driven retail intelligence has become a critical source of competitive advantage, enabling

organizations to enhance efficiency, improve customer experiences, and achieve sustainable growth.

5.1 IoT Data Analytics in Retail

IoT-enabled retail environments generate vast amounts of structured and unstructured data from sensors, RFID systems, smart shelves, mobile applications, point-of-sale systems, and customer interactions. Data analytics serves as the mechanism through which this information is processed, interpreted, and transformed into valuable business intelligence. IoT data analytics involves collecting, integrating, cleaning, and analyzing data from multiple sources to support informed decision-making and operational optimization. Retail organizations utilize descriptive, diagnostic, predictive, and prescriptive analytics to understand historical performance, identify operational issues, forecast future outcomes, and recommend appropriate actions. Real-time analytics platforms process continuous streams of IoT-generated data, enabling immediate responses to changing business conditions. For example, retailers can monitor inventory levels, customer traffic patterns, equipment performance, and sales activities simultaneously, gaining comprehensive visibility into operations. The integration of cloud computing, machine learning, and big data technologies further enhances analytical capabilities, allowing organizations to uncover hidden insights and improve strategic planning. As data becomes an increasingly valuable organizational asset, IoT data analytics plays a central role in creating intelligent and responsive retail ecosystems.

5.2 Consumer Behavior Analysis

Understanding consumer behavior has always been a fundamental objective of retail management. IoT technologies provide unprecedented opportunities for analyzing customer preferences, shopping habits, purchasing decisions, and engagement patterns. Through connected devices, retailers can collect detailed information regarding customer interactions across physical and digital channels, enabling the development of comprehensive behavioral profiles. Consumer behavior analysis involves examining data related to store visits, browsing activities, product interactions, purchasing histories, location movements, and loyalty program participation. Advanced analytical models identify patterns and trends that reveal customer preferences, motivations, and decision-making processes. Retailers can use these insights to optimize store layouts, personalize marketing campaigns, improve product assortments, and enhance customer service strategies. Furthermore, behavioral analytics supports customer segmentation by grouping consumers based on shared characteristics and purchasing behaviors. This segmentation enables more targeted and effective marketing initiatives, resulting in improved customer satisfaction and higher conversion rates. As consumer expectations continue to evolve, IoT-driven behavior analysis remains a critical tool for developing customer-centric retail strategies.

5.3 Predictive and Prescriptive Analytics

Predictive and prescriptive analytics represent advanced forms of business intelligence that enable retailers to anticipate future events and optimize decision-making processes. Predictive analytics utilizes historical data, machine learning algorithms, and statistical models to forecast future outcomes such as customer demand, inventory requirements, sales trends, and market conditions. By identifying patterns within large datasets, predictive models help retailers proactively respond to changing business environments and reduce uncertainty in planning activities. Prescriptive analytics extends beyond forecasting by recommending specific actions that maximize desired outcomes. These systems evaluate multiple scenarios and determine optimal strategies based on predefined objectives and constraints. For example, prescriptive analytics can recommend inventory replenishment schedules, promotional strategies, pricing adjustments, and workforce allocation plans. The integration of predictive and prescriptive analytics enables retailers to transition from reactive decision-making to proactive and strategic management approaches. As analytical technologies continue to advance, these capabilities are becoming increasingly important for achieving operational efficiency, risk mitigation, and competitive differentiation.

5.4 AI-Powered Recommendation Systems

AI-powered recommendation systems have become a cornerstone of personalized retail experiences. These systems utilize machine learning algorithms, collaborative filtering techniques, content-based filtering methods, and deep learning models to analyze customer preferences and generate individualized product recommendations. By leveraging data collected from IoT devices, online platforms, purchase histories, and customer interactions, recommendation systems can identify products and services that align with specific customer interests and needs. In retail environments, recommendation systems enhance customer engagement by presenting relevant products at appropriate moments during the shopping journey. Online retailers use these systems to suggest complementary products, while physical stores can deliver personalized recommendations through mobile applications and smart displays. Effective recommendation systems improve customer satisfaction by reducing search efforts and increasing product discovery opportunities. Additionally, retailers benefit from higher conversion rates, increased average order values, and improved customer retention. As AI technologies continue to evolve, recommendation systems are becoming more sophisticated, capable of incorporating contextual information, real-time behaviors, and predictive insights to deliver highly personalized shopping experiences.

5.5 Dynamic Pricing and Demand Forecasting

Dynamic pricing and demand forecasting are essential applications of AI and analytics in modern retail operations. Traditional pricing strategies often rely on static pricing models that may not adequately reflect changing market conditions,

competitor activities, customer demand, or inventory levels. Dynamic pricing systems address these limitations by continuously analyzing real-time data and automatically adjusting prices based on predefined rules and optimization objectives.

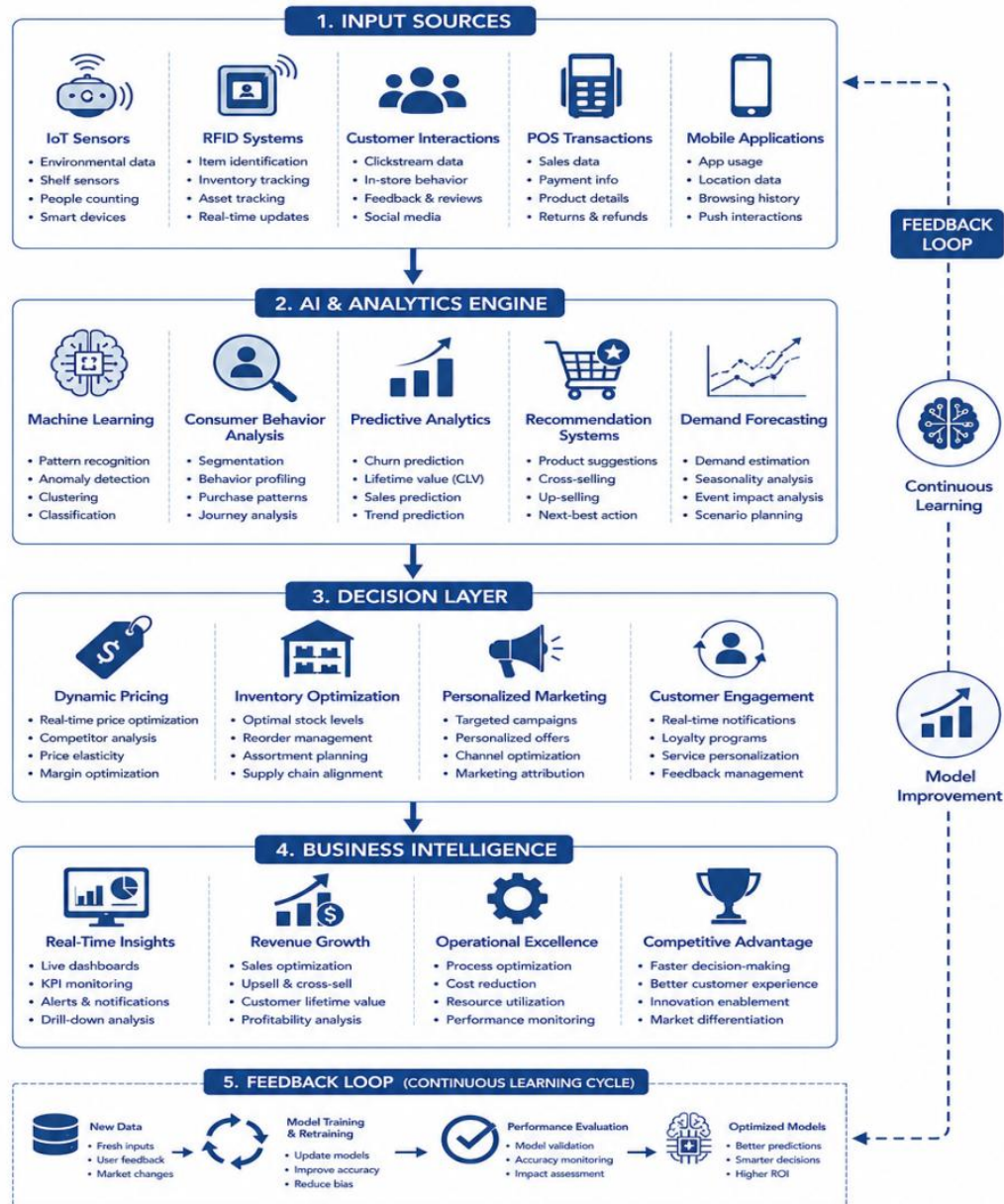


Figure 5.4: AI, Analytics, and Real-Time Retail Intelligence Framework

AI-driven pricing algorithms evaluate multiple factors, including customer behavior, competitor pricing, seasonal trends, inventory availability, and market demand. By responding dynamically to changing conditions, retailers can maximize revenue, improve inventory turnover, and maintain competitive positioning. Simultaneously, demand forecasting models utilize historical sales data, external market indicators, weather conditions, social media trends, and customer behaviors to predict future product demand. Accurate demand forecasting supports inventory planning, supply

chain management, and promotional activities. Together, dynamic pricing and demand forecasting enable retailers to optimize profitability while maintaining high levels of customer satisfaction and operational efficiency.

5.6 Real-Time Retail Intelligence

Real-time retail intelligence refers to the ability to continuously monitor, analyze, and respond to operational and customer-related events as they occur. IoT devices, sensors, and connected systems generate continuous streams of data that provide immediate visibility into retail activities. AI-powered analytics platforms process this information in real time, enabling retailers to identify emerging trends, detect anomalies, and make rapid decisions.

Real-time intelligence supports numerous retail applications, including inventory monitoring, customer engagement, fraud detection, operational optimization, and supply chain management. For example, retailers can identify unexpected demand surges, detect inventory shortages, monitor store traffic, and respond to customer service issues without delay. Real-time dashboards provide decision-makers with comprehensive situational awareness, facilitating agile responses to changing business conditions. As retail environments become increasingly dynamic and customer expectations continue to rise, real-time retail intelligence serves as a critical capability for maintaining competitiveness and delivering superior customer experiences.

VI. EMERGING SMART RETAIL TECHNOLOGIES AND FUTURE TRENDS

The retail industry is experiencing continuous technological innovation driven by advancements in artificial intelligence, IoT, computer vision, immersive technologies, and automation. Emerging smart retail technologies are reshaping how products are marketed, sold, and delivered while creating new opportunities for enhancing operational efficiency and customer engagement. These innovations are enabling retailers to develop highly intelligent, automated, and customer-centric business models capable of adapting to evolving market conditions. As digital transformation accelerates across the retail sector, understanding emerging technologies and future trends becomes essential for organizations seeking to remain competitive in increasingly connected marketplaces. The next generation of retail innovation is expected to be characterized by greater automation, enhanced personalization, improved sustainability, and deeper integration of physical and digital shopping experiences.

6.1 Computer Vision and Smart Surveillance

Computer vision has emerged as a transformative technology in retail environments by enabling machines to interpret and analyze visual information from cameras and imaging systems. Powered by artificial intelligence and deep learning algorithms, computer vision systems can recognize objects, track movements, identify patterns,

and generate actionable insights from visual data. In retail settings, computer vision supports applications such as customer behavior analysis, inventory monitoring, shelf management, security surveillance, and automated checkout systems.

Smart surveillance solutions extend beyond traditional security functions by providing operational intelligence regarding customer traffic patterns, product interactions, queue lengths, and store utilization. Retailers can utilize these insights to optimize store layouts, improve staffing decisions, and enhance customer experiences. Furthermore, computer vision technologies contribute to loss prevention efforts by detecting suspicious activities and monitoring inventory shrinkage. As imaging technologies and AI algorithms continue to improve, computer vision is expected to play an increasingly important role in intelligent retail operations.

6.2 Digital Twins in Retail Operations

Digital twin technology involves the creation of virtual replicas of physical assets, systems, processes, or environments that can be monitored, analyzed, and optimized using real-time data. In retail, digital twins enable organizations to simulate store operations, supply chain activities, inventory flows, and customer interactions within virtual environments. These digital representations continuously receive data from IoT devices, ensuring that virtual models accurately reflect real-world conditions.

Retailers utilize digital twins to test operational strategies, evaluate store layouts, optimize inventory management, and predict system performance under various scenarios. By conducting simulations within digital environments, organizations can identify potential issues and implement improvements without disrupting actual operations. Digital twin technology also supports predictive maintenance, resource optimization, and strategic planning initiatives. As IoT connectivity and computational capabilities expand, digital twins are expected to become valuable tools for enhancing retail efficiency and innovation.

6.3 Augmented Reality and Virtual Reality Shopping

Augmented Reality (AR) and Virtual Reality (VR) technologies are transforming customer experiences by creating immersive and interactive shopping environments. AR overlays digital information onto physical environments, enabling customers to visualize products within real-world contexts using smartphones, tablets, or smart glasses. For example, customers can virtually place furniture within their homes, try on clothing digitally, or access detailed product information through AR applications.

VR technologies create fully immersive virtual environments where customers can explore products, visit virtual stores, and interact with brands remotely. These technologies are particularly valuable for enhancing online shopping experiences and reducing uncertainty associated with product selection. Retailers benefit from

increased customer engagement, improved purchase confidence, and reduced product return rates. As AR and VR technologies become more accessible and sophisticated, they are expected to play a significant role in the future of connected commerce and experiential retailing.

6.4 Autonomous Stores and Cashier-Less Retail

Autonomous stores represent one of the most significant innovations in modern retailing. These stores utilize IoT sensors, computer vision systems, artificial intelligence, and automated payment technologies to eliminate traditional checkout processes and create frictionless shopping experiences. Customers enter stores using mobile applications or digital authentication methods, select desired products, and leave without manually completing transactions.

Computer vision systems and sensor networks continuously monitor product selections and customer movements, automatically generating purchase records and processing payments. Autonomous retail environments offer numerous benefits, including reduced waiting times, improved operational efficiency, lower labor costs, and enhanced customer convenience. As technological capabilities continue to improve, cashier-less retail models are expected to become increasingly prevalent across various retail segments.

6.5 Sustainable and Green Smart Retail Systems

Sustainability has become a strategic priority for retailers seeking to reduce environmental impacts while meeting consumer expectations and regulatory requirements. Smart retail technologies contribute to sustainability objectives by enabling more efficient resource utilization, reducing waste, and optimizing operational processes. IoT-enabled energy management systems monitor and control lighting, heating, cooling, and equipment usage, minimizing energy consumption and operational costs.

Smart inventory management solutions reduce product waste by improving demand forecasting and inventory accuracy. Supply chain visibility technologies support sustainable sourcing practices and environmental monitoring initiatives. Additionally, intelligent transportation systems optimize logistics operations, reducing fuel consumption and carbon emissions. As environmental concerns continue to gain importance, sustainable smart retail systems are expected to play a central role in future retail development and corporate responsibility initiatives.

6.6 Future Directions of IoT-Driven Retail Innovation

The future of retail innovation will be shaped by the continued convergence of IoT, artificial intelligence, edge computing, blockchain, 5G networks, robotics, and immersive technologies. Retail ecosystems are expected to become increasingly autonomous, interconnected, and data-driven, enabling highly personalized customer experiences and intelligent operational management. Advances in AI will

facilitate more sophisticated predictive analytics, automated decision-making, and conversational customer interfaces.

The expansion of 5G networks will support greater device connectivity and real-time data processing capabilities, while edge computing will enable faster and more efficient retail applications. Blockchain technologies may enhance supply chain transparency and product authentication processes. Furthermore, the integration of robotics and automation will continue transforming warehouse operations, customer service functions, and in-store experiences. Collectively, these innovations will drive the next generation of connected commerce and redefine the future of retail.

VII. CHALLENGES, ETHICAL ISSUES, AND FUTURE RESEARCH OPPORTUNITIES

While IoT and smart retail technologies offer substantial benefits, their widespread adoption also introduces significant technical, organizational, ethical, and regulatory challenges. Retailers must address concerns related to data privacy, cybersecurity, interoperability, governance, and ethical decision-making to ensure sustainable and responsible technology deployment. Understanding these challenges is essential for developing robust frameworks that balance innovation with consumer protection and societal well-being. Additionally, the rapidly evolving nature of retail technologies presents numerous opportunities for future research aimed at improving system performance, security, transparency, and sustainability.

Data Privacy and Consumer Trust

IoT-enabled retail environments collect extensive amounts of customer data, including location information, purchasing histories, behavioral patterns, and personal preferences. While this information supports personalized services and operational improvements, it also raises significant privacy concerns. Consumers increasingly expect transparency regarding how their data is collected, stored, and utilized. Retailers must therefore implement strong privacy policies, obtain informed consent, and ensure responsible data management practices. Building and maintaining consumer trust is critical for the long-term success of connected retail ecosystems.

Cybersecurity Risks in Connected Retail

The increasing number of connected devices within retail environments expands potential attack surfaces for cybercriminals. Vulnerabilities in IoT devices, communication networks, cloud platforms, and software applications can expose retailers to data breaches, ransomware attacks, operational disruptions, and financial losses. Effective cybersecurity strategies require comprehensive risk assessments, encryption protocols, authentication mechanisms, network segmentation, and continuous monitoring. As cyber threats become more sophisticated, ensuring the security of connected retail ecosystems remains a top organizational priority.

Regulatory and Compliance Issues

Retail organizations must comply with various regulations governing data protection, consumer rights, cybersecurity, and electronic transactions. Regulatory frameworks continue to evolve in response to emerging technologies and increasing concerns regarding privacy and security. Compliance challenges arise from the complexity of managing large-scale data collection activities across multiple jurisdictions and technology platforms. Organizations must establish governance structures, audit mechanisms, and compliance programs that align with relevant legal and regulatory requirements.

Scalability and Interoperability Challenges

Retail IoT deployments often involve diverse devices, communication protocols, software platforms, and data formats. Ensuring interoperability among these components can be complex and resource-intensive. Additionally, as IoT ecosystems expand, retailers must address scalability challenges related to data processing, network performance, storage requirements, and system management. Developing standardized architectures, communication frameworks, and integration methodologies remains essential for supporting large-scale retail IoT implementations.

Ethical Use of Consumer Data

The extensive use of AI, analytics, and customer profiling technologies raises important ethical considerations regarding fairness, transparency, accountability, and consumer autonomy. Retailers must ensure that data-driven decision-making processes do not result in discriminatory outcomes, manipulation, or unfair treatment of customers. Ethical frameworks should guide the responsible collection, analysis, and application of consumer data while respecting individual rights and societal values. Establishing ethical governance practices is critical for maintaining public confidence in smart retail technologies.

VIII. CONCLUSION

The Internet of Things (IoT) has emerged as a transformative force in the retail industry, fundamentally reshaping how organizations manage operations, engage customers, and create value across increasingly interconnected commerce ecosystems. As retail continues to evolve in response to digital transformation, changing consumer expectations, and technological innovation, IoT serves as a foundational technology that enables seamless integration between physical stores, digital platforms, supply chains, and customer touchpoints. Through the deployment of connected sensors, RFID systems, smart shelves, intelligent devices, cloud-based infrastructures, and advanced communication networks, retailers can collect and analyze vast amounts of real-time data that support more informed, agile, and customer-centric decision-making processes. One of the most significant contributions of IoT in retail is its ability to enhance operational efficiency through

intelligent inventory management and supply chain optimization. Technologies such as RFID-based tracking, automated stock monitoring, predictive inventory systems, and IoT-enabled warehouse automation provide retailers with unprecedented visibility into product movements and inventory conditions. Real-time access to operational data reduces stock discrepancies, minimizes inventory losses, improves demand forecasting accuracy, and enables more efficient resource allocation. Furthermore, enhanced supply chain transparency and traceability contribute to improved product quality, regulatory compliance, sustainability initiatives, and consumer trust. Beyond operational improvements, IoT has revolutionized customer experiences by enabling highly personalized, convenient, and engaging shopping journeys. Smart shopping carts, beacon technologies, location-based services, automated checkout systems, and omnichannel integration create seamless interactions across multiple retail channels.

REFERENCES

- [1]. Porter, M. E., & Heppelmann, J. E. (2014). How smart, connected products are transforming competition. *Harvard Business Review*, 92(11), 64–88.
- [2]. Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks*, 54(15), 2787–2805. <https://doi.org/10.1016/j.comnet.2010.05.010>
- [3]. Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. *Future Generation Computer Systems*, 29(7), 1645–1660. <https://doi.org/10.1016/j.future.2013.01.010>
- [4]. Rose, K., Eldridge, S., & Chapin, L. (2015). *The Internet of Things: An overview*. Internet Society.
- [5]. Wortmann, F., & Flüchter, K. (2015). Internet of Things: Technology and value-added. *Business & Information Systems Engineering*, 57(3), 221–224. <https://doi.org/10.1007/s12599-015-0383-3>
- [6]. Ngai, E. W. T., Moon, K. K. L., Riggins, F. J., & Yi, C. Y. (2008). RFID research: An academic literature review (1995–2005) and future research directions. *International Journal of Production Economics*, 112(2), 510–520. <https://doi.org/10.1016/j.ijpe.2007.05.004>
- [7]. Hardgrave, B. C., Waller, M. A., & Miller, R. (2006). RFID's impact on out-of-stocks: Empirical results from a pilot study. *University of Arkansas Information Technology Research Institute Report*, 1–18.
- [8]. Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics*, 128(1), 77–95. <https://doi.org/10.1016/j.ijpe.2010.07.039>
- [9]. Ben-Daya, M., Hassini, E., & Bahroun, Z. (2019). Internet of Things and supply chain management: A literature review. *International Journal of Production Research*, 57(15–16), 4719–4742. <https://doi.org/10.1080/00207543.2017.1402140>

- [10]. Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of Big Data Analytics and supply chain management. *International Journal of Operations & Production Management*, 37(1), 10–36. <https://doi.org/10.1108/IJOPM-02-2015-0078>
- [11]. Brynjolfsson, E., Hu, Y. J., & Rahman, M. S. (2013). Competing in the age of omnichannel retailing. *MIT Sloan Management Review*, 54(4), 23–29.
- [12]. Verhoef, P. C., Kannan, P. K., & Inman, J. J. (2015). From multi-channel retailing to omnichannel customer experience. *Journal of Retailing*, 91(2), 174–181. <https://doi.org/10.1016/j.jretai.2015.02.005>
- [13]. Rigby, D. (2011). The future of shopping. *Harvard Business Review*, 89(12), 65–76.
- [14]. Pantano, E., & Timmermans, H. (2014). What is smart for retailing? *Procedia Environmental Sciences*, 22, 101–107. <https://doi.org/10.1016/j.proenv.2014.11.010>
- [15]. Grewal, D., Roggeveen, A. L., & Nordfält, J. (2017). The future of retailing. *Journal of Retailing*, 93(1), 1–6. <https://doi.org/10.1016/j.jretai.2016.12.008>
- [16]. Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world. *Harvard Business Review*, 96(1), 108–116.
- [17]. Shankar, V., Inman, J. J., Mantrala, M., Kelley, E., & Rizley, R. (2011). Innovations in shopper marketing: Current insights and future research issues. *Journal of Retailing*, 87(S1), S29–S42. <https://doi.org/10.1016/j.jretai.2011.04.007>
- [18]. Wamba, S. F., Akter, S., Edwards, A., Chopin, G., & Gnanzou, D. (2015). How ‘big data’ can make big impact: Findings from a systematic review and a longitudinal case study. *International Journal of Production Economics*, 165, 234–246. <https://doi.org/10.1016/j.ijpe.2014.12.031>
- [19]. Zeng, B., & Gerritsen, R. (2014). What do we know about social media in tourism? A review. *Tourism Management Perspectives*, 10, 27–36. <https://doi.org/10.1016/j.tmp.2014.01.001>
- [20]. Krotov, V. (2017). The Internet of Things and new business opportunities. *Business Horizons*, 60(6), 831–841. <https://doi.org/10.1016/j.bushor.2017.07.009>