

Retail Surveillance: From Consumers' Interaction to the Process of Data Extraction In-store and Online



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Abstract

In recent years, retail surveillance has evolved into a sophisticated system of data-driven observation and analysis, encompassing both physical store environments and digital platforms. This dual-channel surveillance infrastructure enables retailers to collect, process, and extract vast amounts of consumer data with the goal of enhancing customer experience, optimizing operations, and maximizing profits. The increasing diffusion of technology offers new possibilities to collect data from consumers' interactions automatically. This article aims to provide a comprehensive understanding of the retail technologies available, classified according to different approaches, and the kind of data they can extract from this interaction, emphasizing the customer journey stages. The results show the extent to which the large amount of extracted data might lead to a certain retail surveillance. Consequently, this phenomenon opens new lines of inquiry about the benefits and pitfalls of retail technology surveillance in online and offline shopping settings. The data extraction process involves transforming raw behavioral data into actionable insights. Retailers utilize data analytics platforms to segment consumers, forecast demand, personalize marketing, and manage inventory. While these practices offer clear commercial benefits, they also raise critical questions about transparency, informed consent, and data protection. The convergence of physical and digital surveillance – sometimes referred to as "phygital" surveillance – blurs the boundaries of consumer privacy, demanding renewed scrutiny from regulators, researchers, and civil society. Retail surveillance in both in-store and online contexts has become a central feature of contemporary commerce. As data extraction techniques grow increasingly sophisticated, striking a balance between innovation, customer experience, and ethical data use remains a key challenge for the retail sector.

Keywords: *Retailing, Technology, Surveillance Technologies, Data Analytics, Digital Responsibility, Consumer Journey,*

Competitive Advantage

JEL Classification: C88; D83; L81; M31; O15; O32

The number of available retail technologies to improve the service and consumer experience increases every year, such as retail apps to support in-store visits (from creating the shopping list to identifying the product in the store), contactless payment systems, (online) chatbot, and (in-store) robot to act as shopping assistants. However, anytime a consumer interacts with a technology, either online or in person, the interaction generates a huge amount of information that the retailer might explore to achieve a competitive advantage. Therefore, these technologies observe consumers' data and can deliver customized services or more accurate behavior predictions accordingly. This observational phenomenon largely acquired scholars' and practitioners' attention, trying to understand how to increase consumer benefits over retailers' benefits, limiting consumers' privacy loss. Moreover, recent studies pointed out that the technology is not limited to observing consumers. Instead, it acts as a sort of retail surveillance. Accordingly, recent scholars developed a new concept defining the technological observation of human behavior as dataveillance to describe the online automatic tracing and analysis of individual data and retailance when in brick-and-mortar retail settings, starting from the original concept of surveillance that referred to the generic surveillance of all human behaviors. Thus, retail surveillance embraces the routine and automatic extraction and analysis of consumers' data (including data related to shopping behavior and experience), which can usually be mediated by technology and not consciously disclosed. Despite all this literature, actual studies evaluate retail surveillance technology only regarding consumers' acceptance in online or physical stores.

Theoretical Background

Consumer-computer interaction is a multidimensional domain affecting online and offline store experience, influencing how customers engage with products, services, and brands. Online, consumers traverse a dynamic digital landscape, interacting with various interfaces that shape their retail experience. This includes e-commerce websites, mobile applications, social media platforms, and immersive virtual reality (VR) retail environments. Each interface offers a unique platform for interaction, aiming to captivate and connect consumers with a virtual storefront. **The consumer-computer interactions online encompass diverse levels of immersion and realism. Modern VR experiences represent the pinnacle of immersion, enabling customers to explore stores, visualize products, and simulate the in-store shopping experience.** These interactions, enriched with visual, auditory, and haptic feedback, strive to replicate real-world retail scenarios, fostering a multisensorial feeling of presence and authenticity. Realism is critical in online retail interaction, directly influencing consumer engagement and purchase decisions. High levels of realism, as seen in immersive VR retail and the metaverse, aim to provide an experience closely resembling a visit to a physical store. Customers can virtually inspect products, assess their features, and visualize how they fit into their lives, enhancing their confidence and satisfaction in purchasing. Conversely, simpler interactions, like browsing through product listings on a website, offer functional but less immersive experiences, focusing primarily on ease of navigation and efficient access to product information. Integrating multiple technology media is a common feature of online retail interactions. Incorporating images, videos, interactive graphics, and audio enriches the customer journey, making it visually appealing and informative. These elements help convey product details, showcase usage scenarios, and provide a deeper understanding, enhancing the overall shopping experience. Additionally, these computer-mediated interactions allow tailoring product recommendations, offers, and the overall interface to individual preferences and shopping behaviors, learning from present and past interactions.

In offline retailing, consumer-computer interactions extend beyond e-commerce platforms: interactive displays, touchscreens, and augmented reality (AR) provide customers with engaging and informative experiences, enabling customers -for instance- to virtually try on apparel or visualize how furniture fits into their homes, enhancing their confidence in the decision process. Interactive kiosks allow customers to browse product catalogs, access additional information, and place orders while in-store. **In online and offline retail interactions, interface design and ease of use remain critical factors: intuitive navigation, visually appealing layouts, and seamless user experiences significantly impact how customers perceive a retailer and**

its offerings. In turn, ease of use often translates into quick load times and responsiveness, effortless product exploration and purchase completion, and an intuitive interface. Overall, the evolving landscape of consumer-computer interaction is reshaping the retail industry, blending the digital and physical worlds to offer customers enriched, seamless interactions. Understanding these interactions is paramount for retailers, enabling them to create compelling digital and physical retail spaces that better resonate with consumers.

Ethics in Consumer-Computer Interaction

As anticipated, a huge amount of data can be extracted during consumers' interaction with retail technologies, whose outcomes could be potentially harmful to humans. Consequently, these technologies should be subject to ethical and moral norms. Limited to the online scenario, scholars conceptualized accordingly the role of Corporate Digital Responsibility (CDR) to emphasize the ethical issues unique to the digital context. They specified CDR as the "set of shared values and norms guiding an organization's operations concerning the creation and operation of digital technology and data" by pushing all the actors involved in the development and integration of digital technologies and related data processing to act ethically responsibly. For instance, the data used in retail technology might include information extracted from consumers' photos, including their faces, race, age, skin type, and exact geographical position at any given time. Further data would be obtained from the purchased product size, colors, etc., that could reveal preferences, household size, consumption habits, etc. Indeed, many consumers would not be willing to share this personal information easily. While this data can personalize the shopping experience and improve customer service, it raises concerns about privacy and data security. One major concern is the potential misuse of customer data by retailers or third-party companies. Customers may be uncomfortable when companies use their personal information for marketing or targeted advertising. Additionally, there is the risk of data breaches, which could result in sensitive customer information being stolen and used for malicious purposes.

Data Extraction from Consumers' Interactions with Retail Technology

Literature provides different approaches to classify retail technology. Recent retail technologies can be in the form of touchscreen displays (e.g., virtual fitting systems), mobile applications (e.g., product comparison apps), and hybrid-in-store systems (e.g., RFID recommendation systems). These systems are integrated for two types of stakeholders, namely demand-side and supply-side stakeholders, represented by in-store workers and manufacturers/retailers. Each stakeholder group's purpose of system utilization can be categorized into cost reduction and service enhancement. For instance, customers can enjoy an enhanced experience throughout their customer journey when augmented reality (AR) and virtual reality (VR) technologies are integrated into various touchpoints. For instance, greater convenience has been made possible by deploying technologies that automate the shopping experience, such as self-checkout systems and store grab-and-go options. The grab-and-go option is supported by systems that leverage deep learning, sensors, and transaction automation, allowing customers to retrieve products from shelves without visiting a traditional checkout counter. From a supply-side perspective, the most significant implication of digital innovation in the retail sector, in terms of cost reduction, lies in efficiently managing interactions with customers, inventory records, product identification, and delivery processes, among others.

Certain technologies, such as blockchain and IoT-enabled tracking systems, have the potential to revolutionize inventory management, enhance supplier-retailer communication, and improve supply-chain efficiency. Another classification is based on the technology used at various stages of the customer journey and its value and utility for customers. In the pre-purchase stage, technology's role in customer interaction primarily includes observation, support, and product/service co-creation. During the observation phase, seamlessly interconnected platforms, systems, and smart devices (e.g., Alexa, cloud computing) collect information about customers and the surrounding environment without providing any feedback to

customers in return. The passive operation of technology turns into active interaction when devices, such as chatbots, machine learning, cookie recommendation agents, and geo-targeting apps, come to the forefront. These tools provide location-based notifications in specific geographic areas and support customers searching for relevant products and services. Furthermore, these systems empower the co-creation of products and services by customizing offerings based on individual customer needs.

Customers can co-create services when interacting with systems like chatbots and imagination-enhancing technologies such as augmented reality (AR) applications (e.g., IKEA), virtual showrooms, and kiosks. For instance, IKEA's app allows customers to assess how selected furniture fits into their living space. Interactive chatbots, in particular, simulate human interaction, enhancing the shopping process's experiential value. The observation, support, and product/service co-creation modes manage customer needs and foster engagement in the search process. During the purchase stage, technologies significantly facilitate the transaction process and physically acquire products. Customers engage with machines to receive support in executing transactions or to fully automate certain transactional processes.

Retailers may also employ machines during the shopping phase to observe customers during transactions. Specifically, recommender systems connected with inventory management technology can offer support by suggesting substitutes for out-of-stock items. After the transaction concludes, blockchain and chatbots can ensure transparency in the delivery process by providing regular notifications regarding the status of orders. Support also occurs when individuals employ voice-based assistants (e.g., Alexa) to complete transactions using voice commands. Integrating technologies such as automated payment systems (e- wallets), smart carts, RFID chips, scanners, and drones can further streamline transactions by automating processes related to product ordering, checkout, and delivery.

It's worth noting that facial recognition systems, while not directly controlled by customers, observe customer behavior, capture emotions during interactions with products in stores, and verify payment transactions. Moving to the post-purchase stage, customers primarily receive support from technologies or encounter fully automated follow-up services. Apps powered by machine learning, artificial intelligence (e.g., chatbots), and blockchain play a key role in keeping customers informed about new items similar to those in their purchase history, as well as notifying them about price changes and new service/product upgrades. Automated customer communication enhances engagement and fosters loyalty. Additionally, the automation of follow-up services occurs when IoT-enabled home appliances can identify customers' needs and autonomously process orders without requiring human intervention during the repurchase stage.

The interaction with technology also leads to the extraction of different kinds of consumer data. Specifically, the classification includes six distinct types: identity data, interactional/engagement data, behavioral data, attitudinal data, spatial-temporal data, and other personal data (Table 1).

Customer journey stage	Interaction mode	Types of data and indicative technology collecting / processing it					
		Identity data	Interactional / engagement data	Behavioral data	Attitudinal data	Spatial-temporal data	Other personal data
Pre purchase	Product / service co-creation	Chatbots, VR, and AR technology			Chatbots		
	Support		Cookies	Chatbots, recommender systems		Geo targeting systems	
	Observation			IoT-enabled appliances, cloud computing			
Purchase	Process automation	Automated payment systems, facial recognition systems, RFID tags, scanners		Chatbots, blockchain, recommender systems, voice-based digital assistants, smart cans	Chatbots, blockchain, recommender systems, voice-based digital assistants	Drones	Automated payment systems
	Support						
	Observation	Facial recognition technology					
Post purchase	Process automation			IoT-enabled appliances			IoT-enabled appliances
	Support			Chatbots, Blockchain	Chatbots, Blockchain		

Table 1 - Types of data extracted and processed during consumer-machine interactions.

Source: “Marketing in a Multicultural and Vibrant World, Developments in Marketing Science: Proceedings of the Academy of Marketing Science” (V. Jeseo, J. Parajuli - 2025)

During the pre-purchase stage, while engaging in product/service co-creation, chatbots, AR, and VR technologies can gather socio-demographic characteristics, visual information disclosing individual identities, and attitudinal data, such as preferences and needs. Applications and systems such as cookies, chatbots, recommender systems, and geo-targeting apps simultaneously assist customers while collecting interactional data (e.g., browsing history), behavioral data (e.g., past purchases, wish list items), and spatial-temporal data (customer location and time of interaction). IoT-enabled devices, like smart appliances, can observe customers and collect identity and behavioral data.

During the purchase stage, RFID tags, scanners, blockchain, chatbots, automated payment systems, and drones prove useful for gathering identity, spatial-temporal, and personal data (e.g., bank details) essential for automating product delivery and

purchases. Retailers can access behavioral and attitudinal data through chatbots, blockchain, recommender systems, voice-based digital assistants, and smart carts, with these insights being inferred based on the nature, quantity, and value of purchases made. Observing customers in stores through facial recognition technology facilitates the collection of identity data. In the post-purchase stage, automating follow-up services using IoT-enabled devices results in retrieving behavioral data (e.g., past purchases) and personal data (e.g., bank accounts). Providing post-purchase support and granting access to transactional data through chatbots and blockchain technology becomes possible due to access to customers' behavioral and attitudinal data.

Conclusions

This article provided a comprehensive understanding of the retail technologies available and the kind of data they can extract from this interaction during the three phases of the customer journey. Retail surveillance encompasses the systematic collection and analysis of consumer data, both online and in physical stores, to gain a competitive advantage. This involves tracking consumer behavior through various technologies, often without explicit disclosure to the consumer. The goal is to understand customer preferences and tailor shopping experiences, potentially impacting customer interactions and leading to ethical concerns.

The integration of surveillance technologies in retail environments, both in-store and online, represents a significant shift in how consumer behavior is monitored, analyzed, and utilized. By leveraging tools such as video analytics, Wi-Fi tracking, cookies, and algorithmic profiling, retailers can extract detailed behavioral and transactional data to drive decision-making and personalize the customer experience. These data extraction processes are central to the functioning of modern retail ecosystems, enabling targeted marketing, inventory optimization, and enhanced consumer engagement.

However, this widespread surveillance also introduces critical ethical and regulatory challenges. The continuous collection and analysis of consumer data often occur without explicit consent or clear transparency, raising concerns about individual privacy, data security, and the potential for misuse. Moreover, as physical and digital retail channels become increasingly integrated, the scope and depth of surveillance expand, intensifying these concerns.

In light of these developments, there is a growing need for interdisciplinary research that examines the implications of retail surveillance from technological, legal, and sociocultural perspectives. Regulatory frameworks must evolve to ensure that consumer rights are protected while allowing for innovation within the retail sector. Ultimately, striking a balance between commercial interests and ethical data governance will be essential to fostering trust and accountability in data-driven retail environments.

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