

Real-Time Data Analytics in Retail AI Solutions and Monitoring Tools

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ABSTRACT

The paper aims to evaluate the role that real-time data has played in the improvement of operations in the retail industry. Some of the tools include sensors, cameras, and heat maps on which elaboration is made beginning with their role in tracking foot traffic, mapping of customers' density and their behavior patterns. Other areas of AI being adopted within the different aspects of the supply chain including the discussed topics of supply chain management, new pricing strategies and inventory management are also addressed. In addition emerging trends such as the concept of integrated data solutions, incorporation of IOT, using blockchain for transparency, hyper customization with the help of analytical data models are highlighted.

Keywords: Data Analytics, Monitoring Tools, Big Data, Data Analytics Solutions, Retail, Real-Time Decision Making

1. Introduction

Real-time big data analytics have brought significant changes in operations of the retail industry and customer experience. In highly competitive environments, analytics provides insights into the customer and assists in making strategic choices. Technologies which provide data collection and sensing capabilities like RFID, IoT have facilitated this change. Today a retailer gets a large amount of customer and operation data that the previous generation of systems could not process. In detail, demand forecasting and visibility of stocks have been enhanced to improve inventory management¹.

Big data also enhances supply chain performance and provides information on operations across borders. The use of IoT technology in retail industry has made it possible for sensing, processing, reacting and learning about the market and the customers. This involves the use of big data in areas like demand forecasting and strategic planning. Artificial intelligence and machine learning are some of the technologies that assist in automating processing and operations². AI helps in collection of information whereas machine learning is used to draw something and is used in tasks such as computer vision, finance etc. AI systems adopted by retailers around the globe are

expanding their use to gain competitive advantages. However, issues of data privacy and effective implementation cannot be overlooked.

2. Literature Review

Retail market has been revolutionized with the use of real time big data analytics all over the world. In USA, big retail names such as Walmart and Amazon have started using big data for their operations to enhance customer experience³. As the retail sector in the United States is fast and highly competitive, use of big data enables the retail chains to provide personalized customer experience by designing marketing strategies and pricing subjected to the user⁴. Real-time big data analytics also significantly improves inventory management operations. With the use of technologies like RFID, IoT and advanced data analytic systems, corporations analyze user behavior and then make decisions best catered to it^{5,6}.

In data collection and integration, big data analytics provide a platform for data sources to enhance strategic decision making in retail market⁷. Using Big Data analytics while designing of pricing and marketing strategies serve as a medium for gaining positive market response as it aids in targeted promotions and

smart responsiveness to market trends³. Moreover, big data techniques in inventory management have reduced excessive or over stocking, generate and manage stock availability, decreasing any lossess for the retailer⁸. Globally too, Big Data has enhanced various systemic operations in big and small enterprises. Retailers use Big Data for monitoring of stocks, supply chain, e-commerce internationally and forecasting, hence, resulting in evolution in industry practices⁹.

Furthermore, the retail industry has adapted to real time decision-making which involves several steps constituting the internet of things such as sensing, processing, reacting and learning. A major part of this process requires big data analytics such as sensing of the market trends, user experience and behavior¹⁰. Machine learning and AI tools have sped up the processing and strategizing of different operations in the retail chains. Big Data techniques include AI and machine learning as tools to operate. AI and ML are vital to real time analytics as the former is utilized in processing and collection of data while the latter is a data driven process¹¹. Machine learning specifically is an effective tool in language processing and computer vision while financial trading, forecasting and real-time health data processing¹².

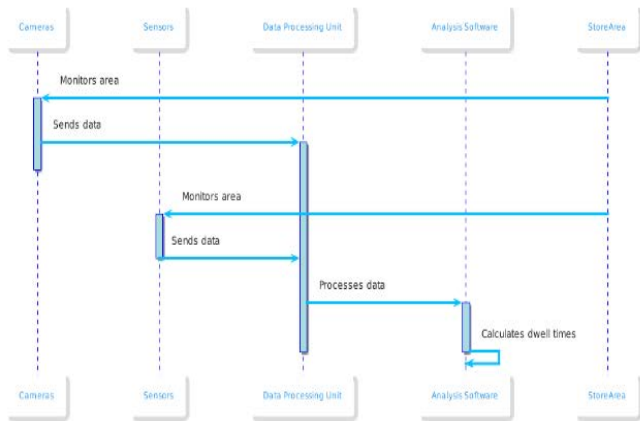


Figure 1: Retail processes using Big Data Analytics¹³.

Consider Figure 1, systemic operations in a retail store constitutes following steps. Camera, being the main tool for sensor uses infrared and heat wave sensors to detect any disparities. They also provide real-time monitoring for customer traffic in stores and warehouse. Data processing and Big Data Analytics follow closely behind¹⁴. Using the described processes and techniques, retailers stay competitive in the market by gaining an edge over retailers that use traditional means for data analysis. Specially, use of big data analytics for forecasting has been studied in context to various algorithms, AI and Machine Learning, widely by the researchers¹⁵. This provides a basis for further research on big date analytic tools, tasks and solutions it conducts and implementation for such techniques. However, to effectively grow in the retail market, retailers should know how to implement big data analytics in operations to get the most out of it. Additionally, the concern over data privacy should not be overlooked either when using such advanced tools for processing and decision-making¹¹.

Consequently, employees and skilled professionals that have a command over big data analytics are crucial for utilizing the techniques to enhance strategic operations in the retail market. China, being the second biggest luxury market, utilizes big data for efficient marketing strategies¹⁶, the study of which can

provide valuable insights into the use of AI and ML based big data analytics.

3. Monitoring Tools and Strategies

Real time Data analytics are adopted by big companies in retail sector for monitoring of their stocks in warehouses as well as customer activities and surveillance throughout the stores. Innovative AI monitoring tools that use big data analytics can be sensors, heat maps and cameras for foot traffic analysis¹⁴. Additionally, the use of big data is also widely known in video analytics for customer assistance¹⁷. Fire and any hazardous detections can also be done using tools such as drones¹⁸. Moreover, facial and voice recognition systems also prove advantageous in retail market for data processing and machine learning.

Foot traffic analysis is generally used in monitoring the traffic and movement of customers throughout the stores which helps in determining customer engagement, product attraction, peak hours and flow patterns. Interpretation of such mesures can enable the retailers to strategize the product promotion, introduction and availability subjected to user experience. Cameras, sensors and heatmaps provide valuable data for such data processes. Cameras and sesnors can help determine the foot traffic in stores by showing the customer engagement towards various aisles and products through which retailers can change product placement accordingly¹⁴. Additionally, heatmaps can detect customer movement and flow patterns for the same purpose as described earlier.

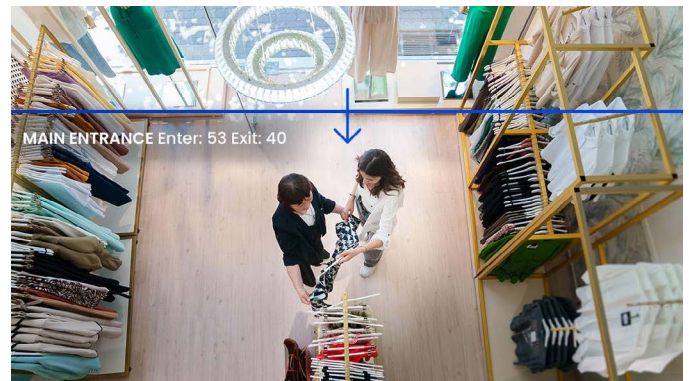


Figure 2: People Counting using in store-camera¹⁹.



Figure 3: Heat mapping using in store sensor-camera¹⁹.

Detection of sudden fire breakout in the stores can also be detected using AI tools and big data processing to help handle it accordingly. Research has shown how with the use of Thing Speak platform, intensity of fires, humidity and temperature can be determined and sensed¹⁸. This can be helpful in retail sector by using sensors that can detect fires. The use of Big Data analytics

to process such data can be beneficial for future planning of infrastructure of retail stores.

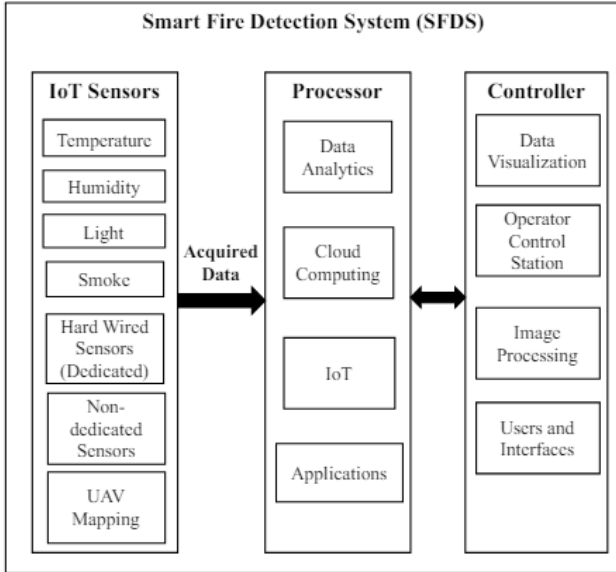


Figure 4: Fire detection systems using AI¹⁸.

Moreover, video analytics are also useful in determination of customer behavior, satisfaction and reviews. Study shows the use of videos recording customer-employee interaction and then processing the data using big data techniques to manage the employee availability and accessibility in high traffic areas¹⁷. This strategy provides an outlet for increased customer satisfaction and enhanced experience which leads to additional sales. Asian countries specifically Japan uses AI robots to assist customers throughout the stores which can also be a valuable monitoring asset.

Furthermore, various data analytics tools are used for programmatic data streaming, query based processing and rule based analytics which is briefed in detail in literature¹². The tools are numerous and widely used in retailing because of its usage of several machine learning languages, codes, programs to provide efficient data driven decisions that comprise different operations in a retail store.



Figure 5: Data Stream Analytic Tools for Real Time Analytics¹².

4. Retail AI Solutions and Implementation

Big Data Analytics are a part and parcel of various strategic operations of retail stores recently. The use of Big Data analytics in retailing can be found in supply chain and logistics²⁰, assortment, pricing and store layout²¹, E-commerce and online

shopping. The implementation of data analytics involves handling the data privacy and other risks efficiently. In supply chain management, retail stores are usually overburdened with big amount of data because of high demands and fluctuation patterns²². Therefore, the use of Big Data techniques and AI models get the work done within minutes and even in real time. Retailers are concerned with gaining a competitive edge over rivals in market²³, for which they require efficient strategies and operations. Big Data Analytics provide a platform to not only generate large amount of data but also processes simultaneously providing many benefits. One of which is that warehouse stocking and any loss, spoilage or wastage of products can easily be caught. Overstocking and understocking can also be managed similarly. Stores such as ALDI and Amzaon²⁴ utilize the same techniques to come up as a leading player in the retail sector.

Assortment, pricing and store layout processes are enhanced with the use of big data analytics. Assortment is the key player in determining the sales of any store and big data analytic techniques are used to efficiently rearrange the products²⁵. This technique enables the retailer to study the relation of the customer preferences of purchases and time and location of the purchases. It also helps in preplanning and determining stock keeping units (SKU) of the store. Similarly, in pricing big data plays a major role. As pricing is usually planned depending on the sales and demand of the products, big data can aid in that. Moreover, promotions also can only be put out after investigating already sold and liked products which is why forecasting, determining of trends is crucial. Using big data flows and information systems, big retail stores in UK like Sainsbury's, Tesco, Morrisons, ASDA, Tesco are able to provide pricing guarantees to the customers²¹.

The growing trends of online shopping among the elders and young are calling for advancement of e-commerce²⁶. Online shopping, as opposed to the conventional one, requires more volume of stocks, fast and quick delivery at all times and serves a wider audience²⁷ which can put a retail store in pressure to deliver. However, with the use of big data, several aims can be achieved. Amazon uses historical data to predict the customer buying trends and this minimizes the time between order and delivery²⁸. Recent big data techniques can also use customer preferences and market trends from social media such as Twitter which can give insights into the popularity of certain products. Consider Figure 6 which show how data from online shopping can be determined. This data can be used by retailers to design promotions, assortment, pricing and forecasting of products.

5. Future Trends

Several technological trends are propelling the future of real-time data analytics in the retail industry. Another notable advancement is that the retail systems have incorporated AI and ML algorithms that can learn from the past data and are capable of predicting future trends and decision making³⁰. These technologies are changing to be prescriptive, anticipating the customers' preferences, and improving the firm's operations. Furthermore, microprocessors, edge computing, and 5G technology are changing the way real-time analytics can happen, offering instantaneous insights on the point of sale³¹.

Thus, such technologies can help retailers improve in-store personalization, dynamic pricing, and real-time inventory management. In addition, AI and ML are used in retail in various ways, including emphasizing the customer journey with different touchpoints in each of the stages, powered by AI and ML³². AI

and ML in retail entail the use of sensors, data, and learning algorithms in the retail system to improve crop management and demand forecasting, among others.



Figure 6: Example of Data Analysis of online shopping²⁹.

The future developments indicate the need for comprehensive data integration solutions where various types of data are integrated smoothly. This is achieved through eliminating silos in different forms of data, thus offering a single perspective of the client engagements. This integrated approach leads to more credible and insightful results. Applying the ideas of block chain can become the key to increasing the level of openness and protection of retail transactions¹¹. Block chain used in real-time analytics to solve the issues like; supply chain and transaction data integrity, thus strengthening consumer credibility.

It was also seen that real-time analytics has been revamping supply chain management with elements of flexibility and reactivity. For the retailers, it is convenient to manage the amount of inventory flow, to understand the patterns of their sales' constant change, and, in this way, be able to promptly determine when there will be possible disruptions [33]. Today's retailers are using real-time data to adapt to the principles of sustainability and optimal product distribution. Consumer are now seeking more openness in product and company and this includes sustainability.

6. Results

Retailers use different AI based monitoring tools in order to conduct real-time analysis. Video surveillance, use of foot traffic sensors and heat map help in acquiring customer traffic pattern information. It enables one to evaluate interactions with products and the aisles, times of the day, and modifications to the layout of stores. The use of image recognition and computer vision allows for people counting and density mapping inside stores. Drones and IoT fire detection sensors alert of safety risks. Customer-employee interactions are also recorded through video analysis to measure service delivery and employee positioning.

Data streaming and querying tools help in programmatic, rule-based and structured analytics. Since retail operations involve generating large volumes of structured and unstructured data, these tools enable efficient analysis and decision making. Block chain has applicability in supply chain and transactions, as it enhances the integrity of data.

7. Conclusion

In conclusion, accelerated development in technologies is defining the future of retail analytics as smart and sophisticated. The integration of AI and machine learning increases proactivity, automation and personalization. Edge computing and 5G transform the speed and scope of insights. New trends include the integration of data as well as analytical tools, predictive supply chain and IoT adoption, and real-time sustainability measurement.

As the monitoring solutions are advancing with the help of computer vision and sensors, it is now time to pay attention to the personalized interactions, dynamic operations, and the transparent ecosystem. Otherwise, the problems of responsible usage of technologies and ethical issues are elements that can make analytics a great tool for making new relevant decisions in the context of the future development of the retail industry.

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