

# Changing Restaurant Behavior: Review

<sup>1</sup>Mohammed Jasim Mohammed Yaseen, <sup>2</sup>Ammar Thaher Yaseen Al Abd Alazeez

<sup>1,2</sup>Department of Computer Science, College of Computer Science and Mathematics, University of Mosul, Mosul, Iraq  
E-mail: [mohammed.23csp70@student.uomosul.edu.iq](mailto:mohammed.23csp70@student.uomosul.edu.iq), ORCID: <sup>1</sup>[0009-0006-4742-6545], <sup>2</sup>[0009-0001-1989-9154]

**Abstract** - Recent behavioral transformations within the restaurant industry have become deeply interconnected with technological advancements, digital analytics, and contemporary marketing methodologies. Customers today exhibit heightened awareness and autonomy in their decision-making processes, extensively relying on digital reviews, social media evaluations, and personal recommendations to guide their dining choices. Consequently, restaurants capable of swiftly adapting to these dynamic market conditions by improving customer experiences, adopting sustainable practices, and effectively utilizing digital data analytics are more likely to achieve sustained success.

This research aims to critically examine recent empirical studies and academic literature that explore behavioral shifts within the restaurant industry. By conducting a systematic analysis of existing research, the study intends to identify the critical factors contributing to restaurants' successes or failures in aligning with evolving consumer expectations. The primary focus will revolve around evaluating the significance of technological integration, sustainability initiatives, and data-driven decision-making practices within restaurants. Ultimately, the findings from this study will provide valuable insights and actionable recommendations for restaurant operators striving to thrive amidst ongoing market transformations.

**Keywords:** Data Stream, Data Mining, Restaurant Behavior Change.

## Introduction

The restaurant industry has undergone significant transformations due to changes in consumption patterns, technological advancements, health awareness, and sustainability concerns, all of which have influenced customer behavior and expectations. These shifts have compelled restaurants to reassess their strategies to maintain competitiveness. Key trends include a growing preference for healthy food, increased reliance on technology, reduction in food waste, and cultural and social influences shaping consumer preferences toward dining experiences [1],[2].

The increasing focus on healthy nutrition has led restaurants to modify their menus, offering healthier options

such as organic and plant-based foods. Today's customers prefer establishments that provide accurate information on calorie counts and nutritional ingredients, influencing their purchasing decisions. This trend has also driven restaurants to adopt cooking techniques that preserve nutrients and minimize the use of harmful substances [3],[4].

Technology has significantly enhanced customer experiences in restaurants through mobile applications, interactive menus, and ordering via QR codes, streamlining operations and reducing wait times. Additionally, artificial intelligence and data analytics have enabled restaurants to predict customer preferences and offer personalized promotions. Smart systems have also improved inventory management and reduced food waste, enhancing operational efficiency [5].

The COVID-19 pandemic led to a shift in both customer behavior and restaurant operations, increasing reliance on delivery and takeout services while emphasizing hygiene and social distancing measures. As a result, restaurants have reinforced safety protocols, such as designing open spaces and implementing automated sanitation systems. These changes have become permanent practices, fostering customer trust in dining establishments [6],[7].

Sustainability has become a core aspect of restaurant strategies, with a focus on minimizing food waste, sourcing sustainable ingredients, and reducing plastic usage and waste. Environmentally responsible restaurants attract customer support, prompting them to incorporate locally sourced ingredients and seasonal plant-based meals. These sustainability efforts enhance restaurant appeal by offering a healthy and eco-friendly dining experience [8],[9].

Social and cultural factors play a crucial role in shaping restaurant behaviors, as customers seek unique dining experiences that reflect their cultural identities or explore global cuisines. Restaurants that offer diverse culinary options attract a broader audience, especially with the influence of social media. Many establishments incorporate culturally inspired interior designs, host workshops, and organize tasting sessions to promote engagement, increasing customer loyalty and restaurant popularity [10],[11].

Customers increasingly favor personalized dining experiences tailored to their needs, encouraging restaurants to offer customizable meal options based on ingredients and portion sizes. Technology has facilitated this process through applications that enable order customization, while some restaurants have integrated artificial intelligence to suggest food options based on consumption patterns, enhancing customer satisfaction and making dining experiences more unique [12],[13].

### Data Stream

In recent years, there has been a significant and immense evolution in device technology and emerging new technologies, which have introduced continuous data collection methods. These include sensor networks, mobile devices, satellites, telecommunications, healthcare sectors, and communication institutions, among others (Soumaya et al., 2017). This type of data is referred to as a Data Stream, which consists of a continuous sequence of elements and data originating from multiple sources. This has created the need for fast data stream processing systems that can handle and analyze data in the shortest possible time.

Every minute on social media, Facebook users post 510,000 comments, update 293,000 statuses, upload 240,000 images, and send 9 million messages. Meanwhile, 500 hours of content are uploaded to YouTube, Twitter sees 4 billion sessions, 28,000 subscribers watch Netflix, more than 5,900,000 searches are conducted on Google, and 5,000 people download the TikTok app. We are living in an advanced digital era where data processing can practically occur in real time. The exponential growth in data production is driven by our unprecedented ability to generate and share vast amounts of information [14].

The term Data Stream in the field of information technology refers to a set of digital signals that transmit various types of data. Modern technologies rely on data streams in multiple ways, enabling industrial standards to facilitate access to data at both individual levels and within global networks.

Some common examples of data streams include continuous data collection processes, such as meteorological station recordings during storms, satellite imagery data, user click statistics on websites, video uploads on YouTube, and data streams generated by the Internet of Things (IoT) and other smart devices.

Stream processing involves continuously updating data, allowing for the extraction of new insights and the discovery of emerging knowledge patterns. Data in streams can either be structured or unstructured [15].

### Characteristics of Data Streams

Streaming data possesses a set of fundamental characteristics that define its nature and processing [16].

1. **Timestamp:** Each element in streaming data contains a timestamp, making it time-sensitive. As time passes, the relevance of data decreases, which affects its usability in analysis and processing.
2. **Continuous:** Data streams (Data Streams) do not have a defined beginning or end, as data is continuously collected and processed (Continuous Processing).
3. **Unique:** The repeated transmission of data streams poses a major challenge due to their time sensitivity. Therefore, real-time processing is essential to ensure data accuracy, as each data element is processed at least once (At Least Once Processing).
4. **Heterogeneous:** Streaming data comes from multiple sources, leading to data variability in terms of quality and format. This requires advanced data integration and processing techniques to handle inconsistencies.
5. **Very Large Data:** The volume of streaming data can be massive (Massive Data Volume), making it impractical to store all data in memory (Memory Storage). This necessitates the use of Big Data Management techniques and efficient storage and processing solutions.

### Challenges of Data Streams

Data streams exhibit characteristics that differ from traditional data, primarily due to the unique challenges associated with data stream processing. This section discusses the key challenges arising from data streams, as identified in previous studies [17].

1. **Infinite Flow & Limited Memory:** Data streams are continuous and un-bounded, creating challenges related to limited memory, as it is impractical to store all incoming data. Therefore, data reduction techniques such as windowing and sampling are used, allowing each data sample to pass through once before being either deleted or stored if necessary.
2. **High-Speed & Uncontrollable Arrival:** Data stream sources generate continuous and fast-flowing data, making it impossible to control the arrival rate. This presents a challenge in handling high-speed data samples that arrive in real-time over the internet.
3. **Real-Time Processing Requirement:** Data stream technologies rely on linear or near-linear algorithms that must be executed in real-time, demanding an immediate response. Therefore, runtime performance is a critical factor in ensuring that data samples are processed quickly and efficiently.

4. Heterogeneity & High-Dimensionality: Data streams exhibit heterogeneity due to the variety of sources and applications, leading to high-dimensional data and imbalanced label distributions. These complexities pose challenges in data integration and processing.
5. Dynamic Nature & Concept Drift: The distribution of data streams evolves over time, leading to concept drift, where patterns change, and the accuracy of models declines. To address this issue, algorithms must be continuously updated and adapted to keep up with these dynamic changes.

### Data Stream Processing Tools

Data stream processing tools are used for real-time processing and analysis of streaming data, enabling instant responses and dynamic analytics. These tools are widely employed in various applications such as big data analysis, real-time monitoring, and the Internet of Things (IoT) [18].

#### Tools Used in Data Stream Processing:

##### 1. Apache Spark

This open-source framework provides an effective solution for real-time data stream processing. It relies on Small Batch Processing techniques to handle large volumes of data in small batches. It also includes the Spark Streaming library, which enables efficient stream processing. Apache Spark supports multiple programming languages, including Java, Python, Scala, and R, making it flexible and easy to use. Additionally, it features low latency, making it an ideal tool for fast analytics.

##### 2. Apache Kafka

This distributed open-source system is an ideal solution for handling massive data streams, offering an efficient mechanism for real-time data transport and processing. It also allows integration with streaming analytics frameworks such as Spark, Flink, and Storm, enhancing its efficiency in complex environments.

##### 3. Apache Storm

This open-source framework is a powerful tool for real-time stream processing, capable of handling large volumes of streaming data at high speed without affecting performance. It also integrates with Kafka, enabling seamless data acquisition and instant analysis with high efficiency.

##### 4. Apache Flink

This high-performance distributed computing platform supports continuous stream processing and real-time big data

handling. It offers APIs for Java, Scala, and Python, making it flexible and easy to integrate with various applications.

##### 5. Python

The Python programming language is widely used in stream data analysis, providing powerful libraries that support various tasks. Notable libraries include:

- Pandas for data processing and analysis,
- Dask for distributed computing,
- TensorFlow and PyTorch for applying machine learning techniques to analyze streaming data effectively.

### Data Stream General Processes Framework (DS General Processes Framework)

"Nguyen et al." proposed a traditional model for data stream mining.

When data streams arrive in the first stage, a buffer is used to store incoming data points in the second stage.

To maintain output consistency with new incoming data, one of the time window models is applied in the third stage, such as the Reference Window, Variable Time Window, Fuzzy Window, or Sliding Window.

Next, the stream processing engine in the fourth stage applies a mining technique in the fifth stage to generate the outputs.

In the sixth stage, processing methodologies such as incremental learning or two-phase learning are applied.

The summary is stored in the data memory in the seventh stage. Data structures such as the Prototype Array, Cluster Feature Vector, Core Tree, and Grid Data are used.

Finally, when certain conditions are met, such as a user request or after a specific period, the system processes the summary and produces approximate results, while implementing data stream verification mechanisms to evaluate output quality in the eighth stage.

Ultimately, the final output is obtained in the ninth stage [19].

### NoSQL Database Types

Some articles mention four main types, while others list six types. In this post, we will review the four primary types of NoSQL databases: Wide-Column Store, Document Store, Key-Value Store, and Graph Store [20].

## 1. Wide-Column Store

As the name suggests, Wide-Column Stores use columns to store data. Related columns can be grouped into column families, and individual rows form part of a column family.

Examples of Wide-Column Store databases include Cassandra and HBase (see Fig. 1).

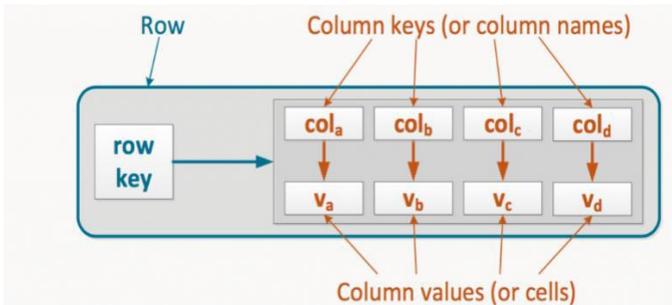


Figure 1: Illustrates what an individual row looks like within a column family in Cassandra

A typical column family contains a row key as the first column, which uniquely identifies the row within the column family. The following columns contain a column key, which uniquely identifies each column within the row; allowing queries to retrieve the corresponding column values (see Fig. 2).

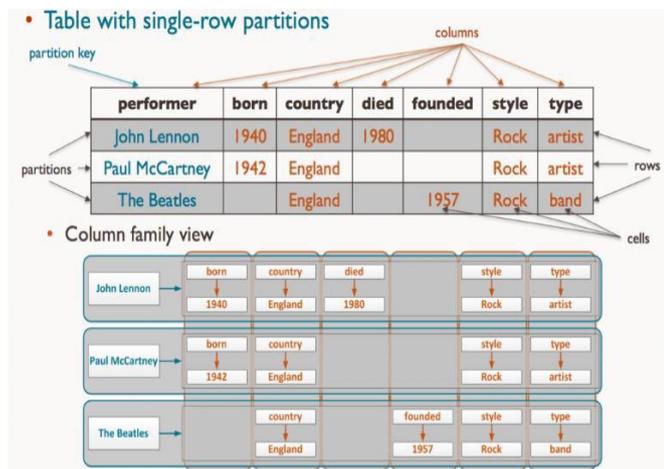


Figure 2: Illustrates the transformation of data from a relational table into a column family

## 2. Document Store

Document Store databases use JSON, XML, or BSON documents to store data. You can structure a document with any data you want. Documents may have different structures, but common fields can be indexed to improve performance (see Fig. 3).

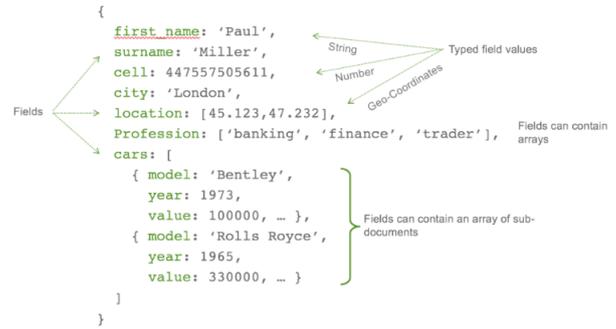


Figure 3: Example of a document in MongoDB

## 3. Key-Value Data Store

Key-Value Data Stores store data in unique key-value pairs, meaning each key is associated with only one value in the collection, similar to a dictionary. This simple model makes querying extremely fast, as no query language is required. Retrieving data is as straightforward as using get, put, and delete commands.

Examples of open-source and free key-value databases include Redis and Memcached.

## 4. Graph Store

Nodes and relationships define Graph Databases. A node represents an entity, such as a user, category, or data object, while a relationship defines how two nodes are connected.

Graph databases store nodes that contain lists of relationship records, allowing direct connections between nodes. This eliminates the need for time-consuming search matching found in relational databases.

Examples of Graph Databases include Neo4j and Janus Graph (see Fig. 4).

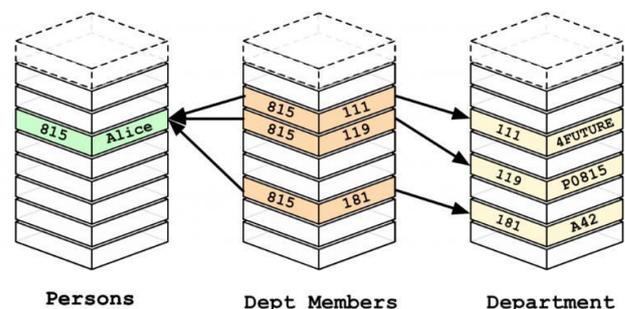


Figure 4: Illustrates the operation of a relational database such as MySQL, which requires complex and memory-intensive join operations to search through entire tables for matching records

## Data Mining

Computers and peripheral devices have become more accessible and affordable, contributing to the advancement of data mining (DM) techniques.

Modern methods rely on advanced characterization techniques to handle complex datasets, such as multidimensional data and web data, which helps improve model accuracy and extract valuable information.

Modern DM techniques include classification, clustering, regression, and association rule mining.

As demand increases, soft computing has emerged as a new enabling approach, where DM processes are divided into:

Descriptive: Identifies data features.

Predictive: Predicts outcomes based on recognized patterns.

However, standardizing terminology across institutions remains a challenge, affecting application efficiency [14].

## Data Mining

Data Mining is the process of analyzing and extracting hidden patterns and relationships within large datasets to build predictive models that support decision-making. This process involves several key tasks, including Classification, Association Rule Mining, and Clustering, which contribute to improving data analysis accuracy and extracting valuable insights.

**Classification:** Classification is the process of assigning new data points to predefined categories based on patterns extracted from data. This is achieved by creating a predictive model using labeled training data, such as a Decision Tree, which is later applied to classify unlabeled data into appropriate categories.

**Association Rule Mining:** This technique is used to discover relationships between different attributes within a dataset, helping identify frequent patterns that have a higher correlation than random occurrences. Association rule mining is widely applied in areas such as consumer behavior analysis and intelligent recommendations.

**Clustering:** Clustering is an analytical method aimed at dividing data into homogeneous groups based on the similarity between elements. Unlike Classification, Clustering does not rely on predefined categories but instead explores the internal structure of data to identify groups that share similar characteristics.

Both Association Rule Mining and Clustering fall under Unsupervised Learning techniques, as they do not require pre-labeled data. In contrast, Classification is considered a Supervised Learning technique because it relies on training data with predefined categories [19].

## Characteristics of Data Mining

Data mining methods have several general characteristics, including:

### 1. Ability to Handle Complex Problems

Data mining (DM) techniques aim to automatically discover useful information from complex datasets, enabling knowledge extraction and predictive analysis.

### 2. Automatic Discovery of Unknown Patterns

Data mining methods automatically detect patterns, which helps in identifying fraud (Discover Fraud) and errors in transactions (Errors in Transactions).

### 3. Capability to Handle Large Volumes of Data

One of the key advantages of data mining techniques is their ability to process and analyze massive datasets efficiently.

### 4. Learning Capability

Many data mining methods have learning abilities, as they gain experience from previous mistakes, leading to automatic improvement of model quality over time [18].

## Restaurant Behavior Change

**Key Trends in Restaurant Behavior:** Customer behavior is rapidly evolving, with diners becoming more value-conscious, seeking a balance between quality and price. Online reviews and recommendations significantly influence their decisions. Diverse menus are now essential to attract customers, while previous dining experiences play a crucial role in building customer loyalty [21].

**Role of Government Regulations in Changing Restaurant Behavior:** Government regulations impact restaurant behavior by imposing taxes on unhealthy foods, reducing their consumption, and encouraging healthier menu options. Some regulations require restaurants to provide clear nutritional information, helping customers make healthier choices. Additionally, restrictions on advertising unhealthy foods influence restaurant marketing strategies [22].

**Transitioning to a Data-Driven Model:** With technological advancements, customer data analysis has

become critical to restaurant success. Restaurants now leverage artificial intelligence (AI) to offer personalized recommendations based on previous orders. AI also enhances operations management, such as inventory control and wait-time reduction, boosting efficiency and sales [23].

**Impact of Food Delivery Apps on Restaurant Behavior:** The rise of food delivery apps has led to an increased reliance on delivery services, giving rise to cloud kitchens that focus solely on preparing food for delivery. These apps have reshaped marketing strategies, as restaurants invest in ranking higher on app listings. AI and data analytics optimize delivery strategies and promotional offers. However, the surge in delivery demand has also increased plastic waste, raising environmental concerns [24].

**Impact of Economic Crises on Restaurant Behavior:** Economic crises have forced restaurants to adjust pricing due to rising costs of raw materials and energy. Many have introduced discounts and special offers to attract customers. To cut costs, restaurants have reduced dependence on imported ingredients, favoring local sourcing to support the economy. Food waste reduction has become a top priority, with restaurants adopting inventory management strategies to promote sustainability [25].

**Impact of the COVID-19 Pandemic on Restaurant Behavior:** The COVID-19 pandemic forced restaurants to restructure operations, leading many to close physical locations and shift to digital ordering and delivery services. Restaurants invested in contactless payment systems and smart automation to enhance customer experience and minimize direct interactions. Menu adjustments were also made to accommodate quick-service and delivery-friendly options, helping restaurants adapt to market shifts [26].

**Impact of Social Media on Restaurant and Customer Behavior:** Customers increasingly rely on social media platforms when choosing restaurants, with user-generated reviews and shared experiences significantly influencing decisions. Restaurants that offer attractive promotions and high-quality service have a better chance of attracting new customers through digital platforms. Active engagement with customers on social media helps build positive relationships and customer loyalty [27].

**Impact of Digital Reputation on Restaurants:** To enhance their digital reputation, restaurants must focus on improving customer experience holistically, from food quality and service to responsive online engagement. Addressing both positive and negative reviews fosters customer trust. Encouraging positive reviews through incentives such as discounts and special offers can also improve reputation. Digital analytics help restaurants understand customer needs

and provide a better experience, boosting their brand image and popularity [28].

**Key Factors Influencing Customer Satisfaction and Loyalty:** Customer experience in restaurants is shaped by several factors, including physical environment, interior design quality, comfort, and cleanliness. Service quality is now considered more important than food, as customers prioritize fast response times and friendly service. Hygiene and health safety have also become crucial factors, especially post-pandemic, as customers have grown more aware of health and safety measures [29].

## Conclusions and Future Work

### Recent Trends in Restaurant Behavior

Recent trends in restaurant behavior indicate a fundamental shift in customer expectations, where the focus is now on balancing quality and price. Additionally, technology and data play a crucial role in enhancing customer experience and improving operational efficiency.

Economic crises and the pandemic have driven restaurants to adopt more flexible and sustainable strategies, such as relying on local sourcing, reducing food waste, and investing in digital technologies.

Moreover, digital reputation and social media now have a significant impact on customer decisions, requiring restaurants to focus on service quality and active engagement with online reviews.

In the context of future studies, it is possible to explore the impact of advanced artificial intelligence on more precise personalization of customer experiences, as well as to investigate methods for enhancing sustainability strategies aimed at reducing plastic waste generated by delivery services. Furthermore, research could examine how future legislation may influence the restaurant industry, particularly concerning taxes on un-healthy foods or restrictions on marketing practices. Additionally, studying the evolution of cloud kitchens and emerging business models within the restaurant sector could contribute significantly to identifying future opportunities and challenges in this rapidly changing industry.

## REFERENCES

- [1] Agbenyegah, A.T., Zogli, L.K.J., Dlamini, B., Mofokeng, N.E.M.D., Kabange, M.M.: Ambient Situation and Customer Satisfaction in Restaurant Businesses: A Management Perspective. *African J. Hosp. Tour. Leis.* 11, 394–408 (2022). <https://doi.org/10.46222/ajhtl.19770720.232>.

- [2] Liu, Y., Ting, H., Ringle, C.: Appreciation to and Behavior Intention Regarding Upscale Ethnic Restaurants. *J. Hosp. Tour. Res.* 47, 235–256 (2023). <https://doi.org/10.1177/10963480211011544>.
- [3] Schifferstein, H.N.: Changing food behaviors in a desirable direction, (2020). <https://doi.org/10.1016/j.cofs.2019.11.002>.
- [4] Using behavioural science to promote sustainable diets around the world.
- [5] Jahan, S., Bhaumik, A., Abid, S., Tiwari, K.: Consumer Behaviour Towards Mobile Marketing in UAE Restaurants: Application of Technology Acceptance Model. In: *Frontiers in Artificial Intelligence and Applications*. pp. 249–256. IOS Press BV (2022). <https://doi.org/10.3233/FAIA220390>.
- [6] Fechner, D., Karl, M., Grün, B., Dolnicar, S.: How can restaurants entice patrons to order environmentally sustainable dishes? Testing new approaches based on hedonic psychology and affective forecasting theory. *J. Sustain. Tour.* (2023). <https://doi.org/10.1080/09669582.2023.2274283>.
- [7] Kim, W., Che, C., Jeong, C.: Restaurant customers' food leftover reduction intention derived from nature connection and biospheric values: A comparison between men and women. *Front. Psychol.* 13, (2023). <https://doi.org/10.3389/fpsyg.2022.976102>.
- [8] Mohammad, A., Aldmour, R., Al-Hawary, S.: Drivers of online food delivery orientation. *Int. J. Data Netw. Sci.* 6, 1619–1624 (2022). <https://doi.org/10.5267/j.ijdns.2022.4.016>.
- [9] Kumolu-Johnson, B.: Improving Service Quality in the Fast-Food Service Industry. *J. Serv. Sci. Manag.* 17, 55–74 (2024). <https://doi.org/10.4236/jssm.2024.171002>.
- [10] Liu, Y., Ting, H., Ringle, C.: Appreciation to and Behavior Intention Regarding Upscale Ethnic Restaurants. *J. Hosp. Tour. Res.* 47, 235–256 (2023). <https://doi.org/10.1177/10963480211011544>.
- [11] Rajput, A., Gahfoor, R.Z.: Satisfaction and revisit intentions at fast food restaurants. *Futur. Bus. J.* 6, (2020). <https://doi.org/10.1186/s43093-020-00021-0>.
- [12] Kaewmahaphinyo, T., Nuangjamnong, C., Dowpiset, K.: Factors Influencing Customer Satisfaction and Behavioral Intention for Fast-Casual Restaurants (A Case Study in a Shopping Center, Bangkok). (2020).
- [13] Creating dynamic value for markets, models, and mechanics.
- [14] Thanoon, M.Y.S.: Concept Drift Effect in Streaming Database for Computer Science Department Staff. (2023).
- [15] Sheet, M.Y., Alazeez, A.T.Y.T.A.A.: The Data Stream Principles, Tools and Applications: A Review. 2022 8th Int. Conf. Contemp. Inf. Technol. Math. ICCITM 2022. 53–58 (2022). <https://doi.org/10.1109/ICCITM56309.2022.10031765>.
- [16] Salih, A.M., Thaher, A., Al, Y., Alazeez, A.: Mining Streaming Database: A Review. (2024).
- [17] Al-Khamees, H.A.A., Al-A'araji, N., Al-Shamery, E.S.: Data Stream: Statistics, Challenges, Concept Drift Detector Methods, Applications and Datasets. *Int. J. Comput. Digit. Syst.* 13, 717–728 (2023). <https://doi.org/10.12785/ijcds/130157>.
- [18] Yousef, A.M.S.: Classifying Lectures in Streaming Database of Computer Science Department A. (2024).
- [19] Al Abd Alazeez, A.T.Y.A.A.A.: Data Stream Mining Between Classical and Modern Applications: A Review. *J. Educ. Sci.* 30, 30–43 (2021). <https://doi.org/10.33899/edusj.2021.130093.1158>.
- [20] No Title, <https://studio3t.com/knowledge-base/articles/nosql-database-types>, last accessed 2025/01/13.
- [21] B.-L.C., Shahrim Karim, Sanghyeop Lee 2 and Heesup Han 3, \*: Customer Restaurant Choice: An Empirical Analysis of Restaurant Types and Eating-out Occasions.
- [22] Zigmond, J.: Behavioral change., (2010).
- [23] Alison Schilling, C.D.: The Evolution of Data in Restaurants: Getting to Know Your Guest, (2022).
- [24] DISEASES, W.E. 2 O.F.T.P.A.C.O.N.: slide to order a food systems approach to meal delivery apps, (2021).
- [25] Grunertetal.2023.pdf.
- [26] DigitalTransformationRestaurantIndustryJSTPre-Print.pdf, (2021).
- [27] BERJ15324Article3p.257-275.pdf, (2024).
- [28] IJIFNSA-D-2-2024.pdf, (2024).
- [29] Customer behaviour in restaurants before and during COVID-19: A study in Vietnam, (2021).



**Citation of this Article:**

Mohammed Jasim Mohammed Yaseen, & Ammar Thaher Yaseen Al Abd Alazeez. (2025). Changing Restaurant Behavior: Review. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 9(10), 88-95. Article DOI <https://doi.org/10.47001/IRJIET/2025.910012>

\*\*\*\*\*