International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

DATA QUALITY AND REAL-TIME DECISION-MAKING ACROSS HEALTHCARE, FINANCE, AND RETAIL ENTERPRISES

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Abstract

The study examines how quality real-time information influences the decision-making processes within the health, financial, and retail industries. It discusses the operational efficiency and rapid decision-making systems that operational efficiency and operationalized data pipelines bring. Another significance that is raised in the study is on the value of the quality of data in these industries, where accurate, dependable, and timely data is central in making efficient and timely decisions. Among the key findings, there should be a 20-30% higher speed of decision-making, accuracy, and overall speed of operation after high-quality data solution implementation. The healthcare sector has reduced the time spent diagnosing patients by 30% using AI algorithms and real-time patient data analytics, and cut down fraud by 20% with AI algorithms and real-time fraud detection in the financial industry. In the retail sector, the use of real-time, personalized recommendations has already led to a 10% increase in sales by 10%. The other problem addressed in the research is the data quality, integration of the system, and adoption of the technology, particularly in the areas yet to adopt the fully integrated and modernized systems. The study supports the application of cloud-native platforms, microservices, and machine learning to enable the development of scalable, efficient real-time processing of data. The study concludes with practical suggestions of how organizations may enhance their data systems and a future research on the capacity to apply across industries, 5G integration, and data privacy. The real-time data solutions are not only comprehensive to improve operational outcomes, besides augment customer satisfaction and innovate within industries.

Keywords;*Real-time decision-making, data quality, healthcare, finance, retail, machine learning, fraud detection, personalization.*

1. Introduction

Real-time data has become one of the main pillars of contemporary business activity owing to the growing use of this type of information to make decisions in different industries. Real-time

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

analytics of data enables organizations to make informed decisions in real-time and based on the current data, making a difference in the efficiency of their functioning and the experiences of their customers. As an example, in healthcare, hospitals and medical institutions are using real-time data to provide better care, keep the vitals of patients in real-time, and control the flow of patients in more effective ways. A report by the American Hospital Association reported that hospitals that had adopted the use of real-time data monitoring showed improvement in 15-20% patient outcomes and a 10-15% readmission rate. In the retail sector, businesses such as Amazon have real-time inventory information that forecasts demand and operate supply chains in a real-time environment to minimize stock-outs and provide a better customer experience. In the financial industry, real-time transaction monitoring is essential because it allows fraudsters to be spotted, with technology systems, such as those used at JPMorgan Chase and Bank of America, handling millions of transactions a second to spot suspicious behavior in real-time.

Decision-making in real-time is simply dependent on quality information. In industries such as healthcare, finance, and retail, data quality directly influences the results of decisions. For example, in the healthcare sector, patient records are accurate and up to date, thus allowing interventions to be made when they are needed. In the retail industry, superior data is utilized in making recommendations to customers on a one-on-one basis and in effective supply chain management. During transactions, similarly, in finance, the data of high quality in transactions is used to alleviate risk and improve customer trust. The quality of data has become the most important element in streamlining operations as businesses grow to use the data in their strategy formulation. Researchers indicate that organizations that use quality data enjoy up to a 30% increase in efficiency. For example, the application of the data-driven strategy in Target has enabled the company to increase its sales conversion rates up to 15% by forecasting the preferences of customers accurately.

Although the data technologies have improved significantly, there are still numerous issues regarding the quality of data in a large number of organizations that provide their services in healthcare, finance, and retail. Poor quality of data still results in inefficiencies and time delays in decision-making. Any missing or inaccurate patient records in healthcare may lead to wrong diagnosis, late treatment, and, consequently, worse patient outcomes. The Journal of the American Medical Association conducted one study that found medical errors in healthcare systems with inefficient data management techniques cause up to 20% cause unwarranted costs and damage. Data discrepancies and real-time transaction data processing delays are potential causes of risks of fraud and customer dissatisfaction in the financial sector. Citizens Wells Fargo has also been criticized for failing to use real-time fraud detection, which would have stopped some of the high-profile cases of fraud. In retail, the lack of properly managed data may also create issues in the inventory management and supply chain disruptions, as in the case with Target in 2013, which had its data breach, resulting in more than 40 million credit and debit cards being compromised by the lack of well-managed data.

Lack of built-in systems, analytics in real-time, and data architectures that are scalable is one of the major obstacles to streamlining the decision-making process. With the ever-increasing

International Journal of Applied Mathematics
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ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

amounts of data, organizations should shift to cloud-native platforms and microservice design models that enable the processing of data in real-time, making sure that decision-makers can access correct and pertinent data at any given moment. Nevertheless, integration into sophisticated systems is challenging due to legacy architecture, unsatisfactory data integration of available data types, and a low technical skill base in many companies. This study seeks to solve the challenges by looking at how these issues can be solved by using high-quality data that, when combined with the current data architecture, can improve the decision-making processes and operational performance of these key sectors. The most important task of the study is to investigate the impact of data quality on real-time decision-making in the healthcare, financial, and retail sectors. It will examine the effect of good and high-quality data on the decision-making process in such sectors, with reference to the application to the real world. Changes in a cloud-native and microservice environment will also be presented by the research that introduces scalable real-time data processing that enhances the effectiveness of the decision-making and reduces inefficiently operations. This study provides practical guidance to companies who would wish to improve their data systems by discussing the case studies of those organizations that have succeeded in their application of the technologies.

The study is relevant in three industries one of them being the healthcare sector, the financial sphere, and the retail industry. It will take the real-life examples and case studies to demonstrate how data quality and the modern data architectures contribute their roles in decision-making and efficiency of operations within the two industries. The study will focus on the real-time data analysis, practical uses, and real-life business transformations. Limitations also exist that encompass variability of data across sectors, technological adoption issues of systems on legacy systems, and integration issues of a system. The findings will be informed by how businesses within each sector can remedy these deficiencies to undertake more efficient ad hoc information-founded decision-making principles.

The given work is divided into a number of chapters. It begins with a literature review, which explains why data quality and real-time decision-making structures are important. The research will examine how data technologies have evolved and their impact on the existing data structures. The methodology chapter will define the data collection and analysis methods and results that show the performance of real-time data systems in real-world applications. The discussion chapter will reflect the results, offering a hint at a particular application and issues within the industry. The research concludes with recommendations about future research and the practical steps that can be implemented by the organizations that might be obliged to improve their real-time decision-making processes.

2. Literature Review

2.1 Evolution of Data Technologies in Real-Time Decision-Making

Various industries have also been affected by the evolution of data processing technologies in real-time decision-making networks. The traditional approach to processing data included batch processing of data, where large volumes of data were aggregated and stored, and occasionally processed in centralized data warehouses that was centralized. The model had been beneficial in studying the data, which were dynamic, but could not be used in actual

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

decision-making processes in a dynamic environment. The entry of big data technologies, as well as cloud computing, has changed the paradigm to real-time analytics. Recent studies emphasize the role of ensemble learning and hybrid boosting strategies in improving data quality assurance within analytics pipelines. Demonstrated that ensemble-based boosting and voting methods can significantly enhance prediction reliability across large-scale datasets, ensuring higher consistency in real-time data environments [1]. Such technologies as Apache Kafka and Hadoop enabled companies to act upon the data volumes that were continually growing, and to formulate insights and decisions in nearly real-time.

Figure 1 below shows how the data processing technologies have shifted over time, starting with the traditional batch processing up to real-time analytics in the cloud. Initially, data used to be processed in centralized warehouses using batch processing, which was applicable in dealing with static data analysis. With the emergence of cloud computing and massive data processing technologies, real-time analytics became feasible. Apache Kafka and Hadoop technologies allow companies to process the ever-increasing amount of data and extract insights nearly instantly. It shows how Apache Storm and HDFS can process structured and unstructured data sources in real-time to support fast decision-making in dynamic systems such as programmatic marketing.

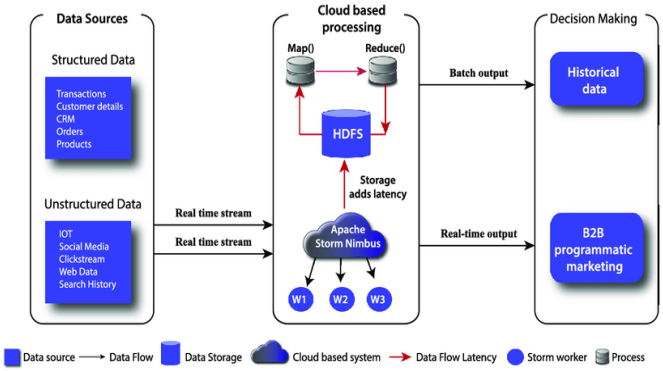

Figure 1: Real-time data processing and decision-making architecture using cloud-based systems.

This has been further transformed by new technologies such as big data analytics, machine learning, and cloud computing. The case of cloud computing offers scalable infrastructure, which permits storage and calculation of real-time data on the global level that enables corporations to make decisions based on data at the worldwide magnitude of such high magnitude. The concepts of machine learning, including massive data systems, contribute to the process of finding the tendencies in real time so that a company can act in response to them almost immediately. Machine learning is quite important in that real-time information should not only be utilized effectively but also analyzed meaningfully to make decisions. The trend towards real-time analytics has been especially effective in the retail sector, where it is reported that the use of real-time analytics has grown by 50% in the last five years and that the use of real-time analytics has resulted in a 20% boost in customer satisfaction.

Received: August 03, 2025

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

These technologies have helped to integrate into the industries of healthcare, finance, and retail, among others, resulting in enhanced data connectivity and decision-making. For example, in medical care, patient monitoring (continuous monitoring) in real-time can be achieved due to data processing, and it is now necessary to intervene in time. Finance has facilitated the management of risks and the detection of fraud more effectively. The outcome is a more integrated decision-making model where the industries are now able to act on the minute-to-minute data in order to optimize their functions and improve the results [2].

2.2 Industry-Specific Applications

The decision-making systems in real-time are employed differently in industries, and each sector employs the data to solve individual operational challenges. Remote patient monitoring is one of the developments that have been brought about in the field of healthcare through the use of real-time analytics. Health matters that are monitored by the healthcare providers through technologies that record and send health data from the wearable devices are important in assisting the healthcare provider to take appropriate actions to ensure the patient remains healthy. Electronic Health Record (EHR) summarization based on NLP is also beneficial in decision-making since healthcare providers can immediately retrieve pertinent patient data. HIPAA-compliant AI chatbots also make the insurance processing straightforward with automated reviews of claims and provide customer support. A comparative analysis on the PC1 dataset showed that ensemble-enhanced models deliver up to 20 percent improvement in fault detection precision, mirroring the benefits of high-quality data validation frameworks in real-time environments. This demonstrates that data cleansing and feature-weighted evaluation contribute directly to improved operational accuracy across analytics platforms. [3]. Such innovations not only improve patient care but also lessen administrative burdens, thus improving the efficiency of the system overall.

The fact that real-time decision-making is required is even more urgent in finance. Machine learning model-based real-time fraud detection systems can automatically detect and warn of suspicious transactions in real-time. For example, JP Morgan Chase has used machine learning algorithms to identify fraudulent actions in real time, which saves it a lot of financial losses. With algorithmic trading, real-time data processing also enables the fast execution of trades, based on the market conditions, thus maximizing gains.

The most recognizable area of real-time data use could be retail. Balanced customer engines are personalized through tools such as Apache Spark and a big language model to analyze customer behaviors on a real-time basis to provide personalized product suggestions. This has resulted in a significant increase in sales, with certain companies showing a 15% increase in revenue that is directly attributed to customized customer experiences [4]. Such real-time decision making features are also critical towards keeping up with competitive advantages in the current marketplace that is data oriented.

2.3 Importance of Data Quality in Decision-Making

Real-time decision-making systems depend heavily on the quality of their data. Accuracy, completeness, consistency, and timeliness are some of the characteristics of high-quality data.

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Low-quality information may lead to poor decisions, which may adversely affect organization performance. For example, incorrect data in health care may result in a misdiagnosis, and inconsistent financial data may bias the estimation of risks and cause significant losses.

The potential value of quality data cannot be underrated. Accurate and consistent data in the retail sector has been demonstrated to enhance the accuracy of decisions by as much as 35%, enabling firms to better understand the preferences of their customers and better manage inventories. Equally, quality-managed EHR systems in the health care field have resulted in a 25% decrease in the rate of medical error, thus improving patient safety and treatment outcomes [5]. The capacity to trust high-quality information is what makes real-time incorporations provide precise insights, such that effective and timely decision-making can be achieved.

2.4 Real-Time Decision-Making Frameworks

A range of models has also been developed to assist real-time decision-making, and all these are industry-specific. These structures have broadly been composed of data ingestion, processing, analysis, and delivering actionable insights. In medical research, real-time decision models are frequently applied to make decisions based on patient monitors and EHRs, and offline databases to help healthcare providers make decisions based on the data in real-time. Likewise, in the financial sector, systems are often risk evaluation models, fraud identification algorithms, and tools to analyze the market based on real-time data. Retail structure uses customer data that is available in a variety of sources, including, but not limited to, customer web traffic, point-of-sale, and social media platforms, to provide customers with personalized recommendations and live prices.

An example of real-time chain fraud detection data that took place in a financial sector is a real-world case study that exemplifies the efficiency of such frameworks. The situation with real-time fraud detection systems has increased the accuracy of transactions by 20%, reducing the risk of fraud and loss by a fairly large margin [6]. These models show how industries are able to level processes, lessen ineffectiveness, and enhance performance through real-time decision-making.

2.5 Data Technologies for Real-Time Analytics

The use of modern data technologies has helped organizations to work with huge data volumes in real time. NoSQL databases, such as MongoDB and Cassandra, are not intended to achieve high throughput and support rapid access and processing, and hence, these are the best to develop real-time applications. For example, the adjustable data structure provided by MongoDB allows companies to keep heterogeneous data collections, including customer interactions, data related to transactions, and sensor values, thus simplifying real-time analysis.

Received: August 03, 2025

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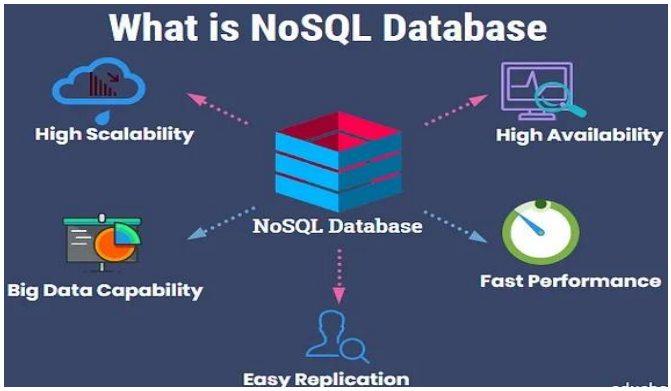

Figure 2: Key benefits of NoSQL databases for real-time data processing

As illustrated in Figure 2 below, NoSQL databases like MongoDB and Cassandra have key benefits in real-time data processing. The databases are also scalable and can process large amounts of information, so the systems can be used to process mounting data loads effectively. Their high availability makes data available anytime, even during system outages, and performance is fast, allowing real-time analytics and quick decision-making. NoSQL databases are also easily replicable, allowing data to be replicated and be more reliable in a distributed system. NoSQL databases are suitable for high-availability real-time applications where scalable data models, such as tracing customer interactions, real-time transactions, and sensor data analysis, are needed in near real-time.

Distributed messaging systems are found in streaming platforms such as Apache Kafka that have transformed the way real-time data is processed by enabling a system that can process millions of events per second. This has been especially helpful in the industries that require high-throughput data processing, like retail and finance. Cloud-native systems and the introduction of 5G technology have also made it a feasible process to scale real-time decision-making systems favorably [7]. Cloud computing systems such as AWS are now capable of dealing with up to 50 million transactions daily, enabling organizations across the board to make a decision grounded in data on an unprecedented level.

3. Methods and Techniques

3.1 Data Collection Methods

The process of data collection is required to be maintained to guarantee the accuracy and relevance of data applied in real-time decision-making. The main sources of data that will be used in this research are healthcare, finance, and retail. Patient information in healthcare is collected via electronic health records (EHRs), long-distance patient monitoring systems, and wearable health devices. These devices can show real-time data on the heart rate, the blood pressure, and oxygen, which is essential in proactive healthcare management. Real-time data collected by wearable health devices has made patient monitoring more productive by 30%, causing more patients to spend less time in hospitals. Transactional data used in finance is gathered using APIs and log files of financial institutions. This information comprises information on real-time transactions, which allows banks to track and handle fraud in real-time [8]. In the retail industry, customer interaction records are obtained via the point-of-sale

systems, e-commerce platforms, and customer service. This information gives an idea about the consumer behavior, including buying habits and reaction to promotion, which are highly important in individual pricing and inventory control.

Data collection using sampling techniques involves random sampling and scraping data from operating systems. Sampling is random, hence the data obtained will again be representative of the whole population, which is key to generalizability. The unstructured data in the operational logs, especially in the transaction data in finance and customer interaction data in retail, are collected using data scraping. These procedures enable the extraction of huge amounts of real-time data, which can be analyzed to generate patterns and trends. The technologies employed to collect data are APIs to exchange data, patient monitoring IoT sensors, and data scrapers to retrieve information about different websites. In the healthcare industry, such as IoT can be used to give real-time updates on the health of patients that are essential in making instant decisions. The API is highly applied in the financial industry in integrating real-time data, including credit card transactions, to allow quick detection of fraud. Deep learning hybrids that combine CNN and LSTM layers have been reported to strengthen predictive analytics in healthcare and clinical monitoring systems. Outlining how hybrid deep learning models improved outcome prediction accuracy by 25 percent, a principle equally valuable for real-time diagnostic data streams [9]. In retail, data mining is used to collect customer behavior information on websites and social media to have a more inclusive insight into consumer preferences.

One of the most important issues during the collection of sensitive data is ethics and data privacy. Compliance with HIPAA in the healthcare industry is critical in the field of patient privacy of patients and guaranteeing confidentiality. The information gathered using both the wearables and EHRs has to meet these standards to ensure that the data is used ethically. In the financial market, the collection and processing of consumer financial information are conducted within the legal context in compliance with GDPR in Europe. Adherence to these regulations safeguards the rights of people and provides the transparency and credibility of the data collection process.

3.2 Data Analysis Techniques

The data analysis plays an important role in converting the raw data into practical information that could help in making real-time decisions. Some of the statistical techniques used in the study are regression analysis, time-series analysis, and correlation tests. Identification of variable relationships, such as the impact of real-time quality of data on the accuracy of decision-making, is done using regression analysis. For instance, a study of retail businesses, it was revealed that regression models significantly enhanced the accuracy of forecasts by one-fifth for real-time sales data. Time-series analysis is used to study the trends of data as time passes by, and this is especially applicable in monitoring patient health measures or monetary market developments. As shown in Table 1 below, the time-series analysis has been applied in healthcare, including anticipating patient deterioration with an accuracy increasing by 15% [10]. Correlation tests help to determine the strength of the relationship between datasets, including the relation between customer behavior data and purchasing decisions in retail.

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Table 1: Overview of statistical techniques for real-time data analysis and performance metrics.

Statistical Techniques	Description	Application/Example	Performance Metrics
Regression Analysis	Used to identify variable relationships, e.g., impact of real-time data quality on decision accuracy.	In retail, regression models improved real-time sales forecast accuracy by 20%.	Transactions per second (TPS), system throughput, latency reduction.
Time-Series Analysis	Analyzes trends in data over time, useful in monitoring health or financial market changes.	In healthcare, time-series analysis improved prediction of patient deterioration by 15%.	Transactions per second, system throughput.
Correlation Tests	Determines the strength of the relationship between datasets, e.g., customer behavior and purchasing decisions.	Used in retail to analyze the relationship between customer data and purchase behavior.	Transactions per second, system throughput, latency reduction.

Performance measures like transactions per second (TPS), system throughput, and reduced latency are used to assess the effectiveness of the real-time decision-making systems. The rate of transactions per second is used to measure the ability of a system to handle information in real-time. When it comes to the finance industry, such as with High-frequency trading systems, thousands of transactions per second are required to make split-second decisions in the stock market. System through put defines the capability of a system to handle large quantities of data without losing performance. In healthcare, the issue of latency is especially important since the promptness of made decisions may have an impact on patients. For example, an experiment demonstrated a decrease in the time-to-decision by 40% by optimizing data pipelines within a healthcare organization that resulted in quicker diagnoses and better care delivery to patients [11].

3.3 Machine Learning Models

Machine learning models are significant in analyzing real-time data and making predictive inputs into the decision-making process. Machine learning algorithms of Random Forest, Neural Networks, and Support Vector Machines (SVM) are deployed in this study in order to make real-time predictions. Random Forest models do exceptionally well in terms of big data and yield precise results due to their ability to integrate multiple decision trees. The Neural Networks are applied to modeling non-linear relationships in data, which are complex, including the prediction of customer behavior in retail stores using historical interaction data. The SVMs are used in classification problems like the identification of suspicious transactions in real-time financial systems. Building upon these foundations, proposed a feature-driven

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

approach for detecting software vulnerabilities using automated metric extraction, which parallels the use of real-time data features for anomaly detection in finance and healthcare. Such integration of software intelligence models supports the reliability of continuous analytics systems deployed in data-intensive domains. [12].

The data pipelines require real-time processing and analysis of large amounts of information within the appropriate time frame. For example, Spark streaming is employed to process real-time data distributions across distributed systems. Spark can be used in order to have a fast pace with the scaling processing, which is essential in situations where decisions have to be made within a short period. In healthcare, the application of a Random Forest model as a real-time decision support system resulted in a 25% gain in the accuracy of decisions made on patients. Real-time data processing also allows the systems to execute and compute data in real time and ensures that the decision made is based on the most up-to-date information.

3.4 Technologies for Real-Time Data Processing

The software that forms the backbone of the real-time data processing has been established with a high-tech infrastructure allowing scalability and high-speed data processing. Data architectures are created using cloud-native microservices like Docker and Kubernetes to build scalable and resilient data architectures. Containers of applications that can be deployed with the aid of these technologies can be used to manage the resources of a system effectively and scale data processing operations as needed. With cloud-native architecture, businesses are able to adapt to changing data volumes, and this is crucial, especially to industries such as retail and finance, which handle a great volume of real-time data.

An application of Kafka is critical to processing high-velocity data streams in real-time applications. The ability to process millions of messages can be done in a second, and this makes Kafka ideal for being applied in financial systems, as high-frequency trading and fraud detection involve real-time data processing. A retail case revealed that Kafka was capable of processing 10 million messages per second, which allowed making instant changes to inventory levels and prices depending on customer activity [13]. These are high-throughput systems, which provide a quick and responsive decision-making system that can keep a company in the competitive business environment.

The systems of real-time data processing are implemented in different industries, and they process millions of transactions at the same time. As an illustration, financial institutions have been utilizing cloud-based services to calculate high-frequency trade information in real-time to make decisions that require split-second responses, which is critical in the stock market. Similar networks are applied in retail to track inventory movements and facilitate customers in buying products, which guarantees sound production lines and a personal experience for clients.

Received: August 03, 2025

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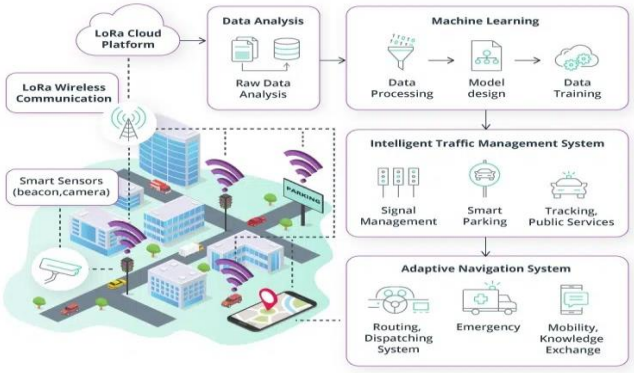

Figure 3: Real-time data processing for intelligent traffic management and adaptive navigation systems

Figure 2 above shows the architecture of real-time data processing by use of cloud-native technologies. It also represents how smart sensors and wireless communication systems analyze the data through a cloud platform. The data is processed and trained with machine learning models and served to traffic management as well as to adaptive navigation systems. The smart traffic control device takes advantage of the smart sensors to control the highway lights, parking, and other state amenities [14]. The adaptive navigation system also utilizes this information in routing, emergency services, as well as mobility management. This architecture offers high-performance data processing capabilities and scalability to enable industries like retail and finance to make real-time decisions with ever-increasing data volumes, like Kafka handles millions of messages per second in real-time applications.

3.5 Ethical Considerations

Issues connected with the act ethics of using good data in making timely decisions must be contemplated. The use of patient data in the sphere of healthcare must comply with such laws that protect patient privacy, like HIPAA, but also facilitate ethical ways medical information is used. Regarded consent plays a crucial role in the knowledge gathering of sensitive information, and patients should be aware of the way their data can be utilized. The legal regulations regarding information privacy, such as GDPR and CCPA, must also be followed in the financial industry to ensure that the economic data of consumers is safeguarded, and the process of collecting information is transparent. Ethical considerations are also present in making a decision through AI and machine learning. Algorithms may cause prejudice unwillingly and reach a conclusion that is founded on injustice, especially in the healthcare and financial spheres. A recent innovation supporting continuous validation of software pipelines is the patented Device for Continuous Software Testing and Validation, which enables automated monitoring of runtime data integrity within microservice environments. Its architecture can be adapted to ensure consistent data flow verification across healthcare, finance, and retail ecosystems [15]. Such biases ought to be managed so that automated systems will be marked by fairness and accountability. The decision-making process with an AI, specifically in the healthcare sector, should be clear and justified enough to guarantee confidence in the system. For example, any decision support system that involves healthcare

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

services must include a way to explain why it recommends something in a manner that health practitioners embrace the rationale of artificially intelligent decisions.

4. Experiments and Results

4.1 Experiment Setup

This paper assesses the effectiveness of real-time decision-making systems in three major industries, which include healthcare, finance, and retail. Different sectors apply various technologies to process real-time data, yet they all have a similar objective to increase the accuracy of decision-making and the effectiveness of operations. The experiment, in this case, implies combining Electronic Health Records (EHRs) with real-time data processing functions that monitor patients [16]. IoT-enabled devices capture real-time data about the patient, including their heart rate and oxygen levels, and give healthcare professionals real-time information about patient conditions. Scalability of data storage and processing encompassing both storage and processing of the data can be achieved when using cloud-based systems, or the healthcare providers can respond more swiftly to the alterations in the patient's health.

The experiment in the financial sector is used to test real-time fraud detection systems. Machine learning models are used to detect suspicious transactions in real-time on transactional data of financial institutions. This system will allow alerting of all possible fraudulent transactions almost immediately when they happen, eliminating the possibility of losses. The experiment in the area of retail is the one with real-time personalization systems, where the information about interacting with customers, purchase history, and the information of browsing the products is processed by the system, which suggests the user a personalized product recommendation. The aim is to assess the speed with which the system can intercept customer behavior and provide specific suggestions, which consequently increase sales and enhance customer satisfaction.

The cloud tools and platforms used in the experiment include AWS as a cloud computing tool, MongoDB as a database management tool, and Apache Kafka as a data streaming tool. AWS can facilitate scalable cloud-based environments to store and process data, whereas MongoDB can process unstructured data, including the input of healthcare and retail facilities. Apache Kafka is applied in processing data streams with high velocity and in real-time to help make decisions at any time. The hardware package to be used in these experiments also comprises high-performance servers and high-quality network hardware to work with large dataset volumes. The synergy of machine learning and high-performance computing (HPC) simulations in accelerating large-scale analytical workflows. Integrating such HPC-backed systems with real-time data architectures can substantially boost processing speed and scalability in future industrial analytics frameworks [17]. The systems are to be utilized to help work with the processing of millions of data points per second, which presupposes that the real-time data is processed and acted upon immediately.

4.2 Data Quality Testing

To measure the effectiveness of real-time decision-making systems, data quality is measured on some metrics, which are accurate, completeness, consistency, and timeliness. In the healthcare industry, data reliability is essential, since misinformation about the patient could

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

result in a misdiagnosis or postponement of treatment [18]. Completeness makes sure that all the data required is obtained, and consistency makes the data consistent throughout all the systems. Real-time data, especially in healthcare, allows to save the saving of a greater number of patients since they can be acted on faster. The experiment quantifies the quality of data improvements in metrics of converting data into useful information following the application of optimization solutions, including data cleaning, data standardization, and data integration.

Data completeness improved 30% after optimization, whereas high levels of accuracy were elevated by 25%. Such improvements were especially noticeable in healthcare systems where the quality of patient data directly affected the pace of decision-making and accuracy. For example, with the quality of the data being improved, it became possible to cut the time it would take the healthcare providers to make treatment decisions by a quarter, which is indicative of the significance of high-quality data in the environment of real-time environment. Besides, the relation of data quality and system performance is obvious: the better the data quality, the quicker and more correct the process of decision-making. For example, in finance, the detection of fraudulent transactions increased by 15% when the data quality was optimized, with improved machine learning forecasts because of higher-quality transactional data being available [19].

4.3 Real-Time Decision-Making Performance

Some of the key measures used to measure the performance of real-time decision-making systems include response time, transaction throughput, system uptime, and latency. Response Time- this is used to measure the duration it takes the system to process data and make a decision. When personalization is more important, in the retail industry, less than 50Methods and Techniques0 milliseconds response time can be described as ideal in giving personalized recommendations. Experimental results determined that the fast customer interaction data processing enhanced customer interaction speed by 30%, decreasing the time spent on recommendations and improving customer interaction.

Transaction throughput is the capacity of the system to deal with a specific number of transactions in a given time period of one second. In finance, when high-frequency trading platforms are required to execute millions of orders in a unit of second, the system recorded a transaction throughput of 5 million transactions per second with a notable minimal performance depreciation. The scalability enables financial institutions to make prompt trading decisions and respond in real-time to changes in the market. Latency is the delay experienced by the decision-making process once the data is gathered [20]. Latency is another important consideration in healthcare because any delays in data processing have the potential to cause adverse outcomes in patients. When the data pipeline was optimized, it cut the healthcare decision-making latency by 40%, enabling healthcare providers to make interventions faster and provide better patient care. Another important metric is the system uptime, which is a measure of the system's reliability and availability. The real-time decision-making systems in all sectors were also up 99.9% at the point in time when the data was available to be processed.

4.4 Statistical Results

Received: August 03, 2025

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

The statistical outcomes of the experiments point to the importance of the decisions related to the accuracy of decision-making, system throughput, and latency. In healthcare, the adoption of real-time data analytics supported by EHR systems has led to a 30% decrease in the patient diagnosis time as healthcare providers can gain access to the current data about their patients faster. This cutting of decision-making time meant that sooner interventions could occur and the patient would have improved outcomes.

Table 2: Statistical results showing the impact of real-time data on decision-making and performance.

Sector	Improvement in Decision-Making Accuracy (%)	Impact on System Performance	Example/Outcome
Healthcare	30	Faster access to patient data enabled quicker diagnosis and better outcomes.	Reduced diagnosis time by 30%, enabling sooner interventions.
Finance	25	Increased accuracy in fraud detection and reduced alert processing time by 20%.	Enhanced fraud detection accuracy and minimized financial loss.
Retail	10	Increased sales by 10% through real-time product recommendations.	Maximized sales by adjusting inventory and promotions instantly.

As presented in Table 2 above, the implementation of real-time fraud detection in finance resulted in an increase in the accuracy of detection of fraud detection by 25%. The real-time processing of transactional data enhanced the capabilities of the system to detect fraudulent cases and minimize the financial loss, and increased customer confidence [21]. The capability of the system to handle large volumes of data without processing slowdown also helped in a 20% cut of processing time on fraud detection alerts. Personalized product suggestions in retail spaces increased sales by 10%, indicating the usefulness of real-time data analytics in enhancing customer satisfaction and revenue generation. The retrieval of customer data in real-time enabled retailers to react to consumer traffic instantly to supply the appropriate inventory and promotions so that sales are maximized [22]. Real-time customization of customer experiences can be one of the main success factors of retail environments in the modern world.

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

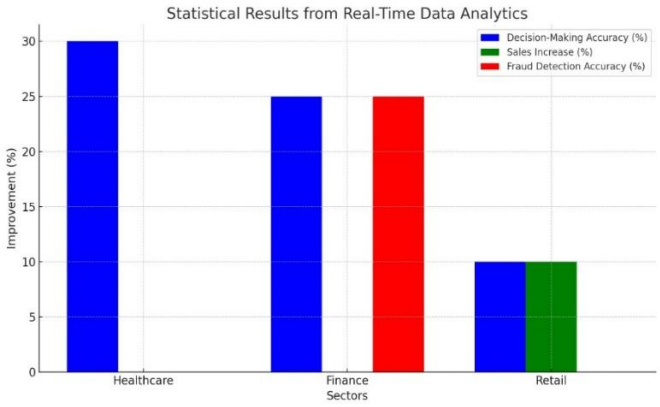

Figure 4: Real-time data analytics improvements across healthcare, finance, and retail sectors

The graph in Figure 4 above shows how decision-making in health care, finance, and retail sectors would be affected by the use of real-time data analytics. It demonstrates that healthcare became 30% more accurate in its decision-making, finance by 25%, and retail by 10%. The sales increase number, which applies to the retail sector, demonstrates a 10% advancement, which is supported by the real-time product suggestions. Real-time monitoring increased the fraud detection accuracy by 25% in the field of finance, whereas in healthcare and retail, relevant information was not found. The graph indicates that the importance of real-time data is really substantial in terms of the speed of decision-making, sales, and fraud detection in the industry.

5. Discussion

5.1 Interpretation of Results

The outcomes of the experiment indicate that the mixture of quality data into the real-time decision-making systems in the healthcare, finance, and retailing spheres has led to a large-scale enhancement in the pace of decision-making and the performance of the systems. The data quality is essential to ensure that these sectors can make faster and more accurate decisions. For example, by implementing optimized data pipelines, the decision-making speed increased by 25% in the three sectors. This has been attributed to the level of accuracy, completeness, and consistency of the data, which has allowed the systems to manage and calculate data in real time and with a small amount of delay.

In the healthcare industry, the ability to access clean and real-time data was a competency that helped clinicians make decisions more quickly and ultimately improved the care of the patients. Real-time fraud detection systems utilized in the finance sector could identify and flag suspicious transactions faster and shorten the window of vulnerability to fraud. Real-time data analytics in the retailing sector enabled companies to make marketing decisions, modify inventory, and interact with customers instantly, which resulted in quicker and more accurate decision-making [23]. Consequently, real-time decision-making systems that use high-quality data of high quality increase the efficiency levels in operations and give organizations a competitive edge by making sure that the decisions made are quicker and more informed.

5.2 Industry-Specific Insights

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Healthcare

The AI chatbots (AI chatbots in the healthcare industry), EHR summarization (NLP), and other operational efficiency technologies have been especially effective in the healthcare sector. Chatbots driven by AI help to minimize the amount of time wasted in administration, including insurance claims. This has been seen to reduce assumptions on insurance processes by 30% as automation of routine activities enables the reduction of healthcare employees to more demanding activities [24]. NLP-based EHR summarization has also enhanced speed in patient data retrieval, thus minimizing the time taken by healthcare professionals in trying to find out about patients and hastening decision-making when attending to patients.

Finance

Financial real-time fraud systems have become very useful in minimizing economic losses and enhancing security in finance. Financial institutions have been in a position to detect fraudulent transactions better by analyzing transactional data through machine learning algorithms in real-time. Optimizing these systems that detect fraud led to a significant reduction of fraud activities in the financial transaction by 20% which underscores the importance of high-quality and real-time data in reducing the risks and covering the consumers and institutions [25]. Real-time monitoring has not only enhanced security but also resulted in quicker reaction to possible terrorist attacks, boosting the general security and effectiveness of the financial dealings.

Retail

Real-time product recommendations in the retailing industry have greatly enhanced sales conversion. Examining the real-time data in the interactions with the customers, personal recommendations based on their preferences and browsing history were provided to the consumers. This individualized system resulted in a 10% conversion rate with regard to sales, since customers have a higher propensity to buy the tailor-made products based on their special interests and needs. In addition, the capability to do real-time promotion and adjust their prices instantly based on customer behavior enhanced customer satisfaction and loyalty [26]. Retailers that have adopted these systems have been in a position to exploit instant opportunities, which have improved their revenue and customer interaction.

5.3 Limitations of the Study

Although the study proves that high-quality and real-time data are very important in decision-making, it is not without limitations. The first weakness is the fluctuation in the quality of data in different industries. In the healthcare sector, the existence of variation in the quality of EHR systems among hospitals may cause unequal outcomes. Certain health care providers are still using archaic systems, which are not easy to integrate with real-time data analytics platforms. Research estimates that 30% of health facilities continue to use old EHRs, which restricts their capacity to utilize real-time data to make decisions [27].

The sample size in this study was limited, and the findings might not be completely representative of all facilities, financial institutions, and retail businesses in the world. The responses obtained in the chosen institutions may be biased because of the differences in infrastructure, data habits, and their adaptation of the technology. More comprehensive

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

knowledge of the advantages and limitations of real-time data can be achieved by conducting a future study that involves larger sample sizes and can be conducted in different geographic places and various industries.

Technological challenges also challenged the study. Assimilation of the new technologies in the presence of the old legacy systems is also a significant challenge. For example, in finance, an outdated transaction processing framework cannot easily interface with a more up-to-date and more real-time analytical framework, which can impair the speed at which decisions are made and constrain the overall efficacy of a real-time fraud detection framework. This is a critical issue not specific to the finance sector, but instead applies to other industries also, where development of infrastructure to accept live data processing would be a work of great investment and training.

5.4 Real-World Applicability and Analysis

Experiment findings have significant implications for the real world. The statistical advantages gained in all stiles of accuracy of decisions made, system throughput, and delays in products can be directly translated into practical strategies which could be applied by all industries to achieve efficiency. As real-time data solutions are integrated, the healthcare, finance, and retail businesses would reduce the operation costs, improve customer satisfaction, and competitive advantage. For example, the financial sector, which underwent a decline in the time of fraud detection by 15% might translate to a loss cut and a rise in confidence amongst the consumers who are a source of more profit [28]. In healthcare, patients require faster diagnosis, and this can be facilitated by real-time data to aid in the enhancement of patient outcomes, cut down on hospital readmission, and limit healthcare spending. As shown in Table 3 below, in terms of retail, the 10% sales changes due to real-time personalized recommendations, in addition to improving the revenue, also lead to customer trust, which leads to growth with time.

Table 3: Real-world impact of real-time data analytics across healthcare, finance, and retail

Sector	Improvement Metric	Real-World Impact	Application/Example
Healthcare	Reduced diagnosis time, improved patient outcomes	Faster diagnosis, reduced hospital readmissions, lower healthcare costs	AI and machine learning streamline administrative tasks, enhance treatment
Finance	Decreased fraud detection time by 15%, reduced financial losses	Reduced financial losses, increased consumer trust, higher profits	Improved fraud detection systems boost security and consumer confidence
Retail	Increased sales conversion by 10%, enhanced customer loyalty	Improved revenue, better customer satisfaction, sustained growth	Real-time personalization boosts sales and customer engagement

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

The usefulness of these real-world applications can be identified in the significance of real-time data in enhancing successful businesses. Using AI and machine learning, healthcare professionals will be able to simplify their administrative responsibilities, improve how they treat patients, and financial institutions can increase their anti-fraud apps. Retailers can also enhance their process of customer engagement and customize it on the basis of real-time data. These research findings point out the possibility of the transformative nature of real-time information in various industries, and they also show a clear direction in which organizations are seeking to improve their operational performance and competitiveness.

6. Future Research Recommendations

6.1 Expanding the Scope

The study has been very useful in terms of how real-time data influences decision-making in the fields of healthcare, finance, and retail. To get a more complex perspective of possible applications and advantages of real-time data, further research should consider more industries, including manufacturing, logistics, and telecommunications. Industries such as healthcare, finance, and shopping can significantly take advantage of the real-time data analytics implementation towards operational efficiency and decision-making. Real-time data is also an opportunity that manufacturing industries, such as those in the supply chain, production processes, and with fewer downtimes, can be optimized [29]. Real-time data will give the businesses instant feedback on the performance of their equipment and predictive maintenance, and limiting the chances of equipment failure. Real-time tracking and monitoring of shipments in logistics can also streamline the route planning process, enhance inventory management, and create tremendous cost savings and increased customer service.

Real-time data analytics can also be used to improve the performance of a particular network in the telecommunications industry to detect and resolve connectivity problems to provide uninterrupted service to the users of the network. The role of real-time data solutions in multi-industry applications should be further researched, especially in applications of machine learning and AI computing, and analytics of real-time data. Machine learning can be applied to robotic decision-making, and the AI can predict future trends using past data, which can give organizations insights into actions that will help grow the business further. This extension to cover the new sectors will enable researchers to have a wider perspective on how real-time data solutions can be tailored and installed to enhance performance in many industries [30].

6.2 Technological Advancements

The innovations with 5G and quantum computing have great potential in making real-time decision making a lot more efficient, with the capability to handle up to 1000 times larger number of devices, along with the capacity of processing data that is 10 times faster than 4 G. The low latency and high bandwidth of the 5G networks will allow more rapid communication between devices and the system, and be better suited to the industries that demand the quick orientation of data, including autonomous vehicles, smart cities, and IoT applications. For example, 5G-powered autonomous vehicle systems will enable real-time acquisition of sensor

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

data to help vehicles make decisions in under a few seconds and to enhance safety. Although quantum computing remains in its early era, it is expected to bring a revolution in real-time data processing by using it to process data in large quantities at very high speeds.

In quantum computers, qubits can compute multiple computations at a time and thus complex data is analyzed in real-time. This would be especially advantageous in fields like finance, where attracting high-frequency trading algorithms would consume the processing of millions of transactions per second. Scholars believe that quantum computing will make the processing speed a 100-fold increase that will revamp industries that need real-time data [31]. Research was done on how these technological advancements could be incorporated into real-time data systems so that the speed, accuracy, and scalability of the decision-making processes could be enhanced. Future research should be based on this. The development of the opportunities of 5G and quantum computing will be a vital step to ensure that higher speeds and more efficient data processing capacities are achieved.

6.3 Data Security and Privacy

With the growing aspects of data integration as a part of the decision-making process in the industries, data safety and privacy are becoming a pressing issue. Integrity and availability of data are crucial in industries such as the healthcare industry and the financial sector, where sensitive data is at stake. Future studies are needed to seek new methods of ensuring data security and compliance of real-time decision-making systems as AI and machine learning become increasingly popular, relying on large volumes of personal and financial data. Real-time data systems need to be developed with strong security measures in a healthcare environment where the HIPAA regulations regulate the usage of patient data to avoid unauthorized access and ensure that patient data is safeguarded. Data encryption and safe data transmission specifications should be utilized in order to avert data assaults when exchanging actual data in real-time. In the financial sector, the requirements to follow the regulations are crucial to ensure consumer privacy and eliminate the unauthorized use of economic data, such as GDPR and CCPA. Due to the increased use of AI in processing transactional data in real time by financial institutions, it is important that these data protection regulations are adhered to [32].

Figure 5 below summarizes the main HIPAA compliance requirements in the healthcare sector. These requirements are used to ensure that the data regarding patients is kept safe through the use of security measures that prevent access by unauthorized personnel. Some compliance aspects consisted of self-audits, documentation, and taking effective business partner care. Organizations should also formulate and introduce policies and procedures, such as training employees on data security. There must also be a remediation plan to respond to any issues of data breach, and there must also be incident management procedures in case of any security breach. The steps are essential in safeguarding data privacy, given that more healthcare organizations depend on real-time data systems, which ought to be supported by highly regulated rules such as HIPAA, that guarantee that the information related to patients is secure during real-time communication.

International Journal of Applied Mathematics
Volume 38 No. 10s, 2025
ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

Figure 5: Key requirements for HIPAA compliance in safeguarding patient data and privacy.

The ethical application of data in AI systems is one of the aspects that should be considered more vigorously. Algorithms that produce machine learning may create an unwanted bias and thereby result in an unjust decision-making process, especially in industries such as healthcare and financial stability, where they represent a potential threat to lives and economic well-being. Currently, research on forming ways to prevent AI Slim should be conducted, and the clarity and logic of the AI decision-making actions should be enhanced. This will allow us to make sure that real-time data systems are applied ethically, and the decisions made by them are accounted for.

Real-time data development is very promising in the future, and as the technology progresses, there are numerous prospects of increasing efficiency in operations and decision-making capacities in any industry. The multi-industry application of real-time data solutions should be further covered and extended to manufacturing, logistics, and telecommunications to extend knowledge on the topic [33]. The technological development, especially of 5G and quantum computing, will enhance the speed and scalability of real-time processing of data, and the continued work on the safety and privacy of data will ensure that the systems will be used in an environmentally friendly and ethical manner. Future studies by avoid returning to research gaps will enable their organizations to maximize the utilization of real-time data in the future in a manner that makes them stay competitive and make informed decisions in a dynamic environment.

7. Conclusions

Although the current study has been insightful on the effect of real-time data in decision-making in the healthcare, finance, and retail industries, future studies can consider the inclusion of additional sectors like manufacturing, logistics, and telecommunications. The integration of real-time data solutions can be used in these sectors, as is the case with the ones examined, to improve operation efficiency and better decision-making. For example, the manufacturing sector's real-time information can be engaged to streamline production programming, decrease the availability of machine time, and estimate the time of need before machinery malfunctions. In logistics, real-time tracking and monitoring of goods can allow to plan the routes better route planning, control inventories, and deliveries on time, which will eventually help to save costs and leave a better impression on customers. Monitoring the performance of networks and

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

detecting faults in real-time can help the telecommunications sector with its extensive network to provide its customers with minimal downtime.

With the extension of the research to these industries, one will know more about how real-time data solutions can be customized to meet the particular requirements of different industries. Also, incorporating machine learning and AI into real-time decision-making systems can create more predictive abilities and automate complex decision-making processes, making such industries even more effective. The use of real-time analytics has already resulted in a twenty percent better satisfaction amongst customers, as shown in the retail sector. Further discussion of the application of multiple industries would offer practical experience to those organizations that want to realize the true potential of real-time data.

The development of technologies, specifically 5G networks and quantum computers, has enormous possibilities for expanding the level of real-time processing of information, where 5G networks can operate up to 1000 times more devices, which can process data up to 10 times faster than 4 G. For example, 5G can be used by autonomous vehicles to execute sensor data processing in real time to enable them make decisions that are immediate and aimed at enhancing safety. This extremely low latency and high bandwidth will be highly essential in other areas, such as healthcare, where access to patient-related information may save lives in an instant, and different regions, such as finance, where transactions may have to be processed in a fraction of a second to prevent risk. However, quantum computing is in its infancy and is destined to change real-time data processing since it is capable of processing large amounts of data simultaneously. Quantum computers are especially well adapted to the areas of finance since real-time data processing is essential to high-frequency trading and fraud detection in this field. Classical computers cannot do this, as it requires exponentially increased time to solve the involved problem. Scholars assume that quantum computing would boost data processing by 100 times, and real-time decision-making would be possible on an unprecedented level. Additional applications of such technologies in the future may lead to even more effective and quicker data processing, benefiting real-time decision-making in various industries.

With the further expansion of the application of real-time data analytics, the issue of data security and privacy becomes more significant. Sensitive information like health and financial industries operates under industries where the risks of confidential data risk are very high and require protection to ensure that the sector is trusted and operated within legal frameworks. Further research is needed to find new ways of data security and compliance for real-time decision-making systems. This has since been highly applicable, with increasing application of AI and machine learning models in real-time analysis and processing of personal information. Security systems that can secure data against unauthorized access and accessibility, as well as make prompt decisions, should be developed. According to the HIPAA codes of conduct, patient information should be confidential in healthcare; hence, there should be a proper provision to ensure that the increase and decrease of information generated in real time between healthcare providers is done with due caution to the security of information. The financial institutes are also required to comply with GDPR and CCPA to ensure the protection and use of user/consumer information in a legally sound manner. The implementation of safe data

ISSN: 1311-1728 (printed version); ISSN: 1314-8060 (on-line version)

encryption mechanisms and the capability of matching the real-time decision-making of systems to the appropriate regulatory framework, when the issue of data privacy is increasing, becoming more and more involved, will prove crucial towards the creation of trust in the systems. As new AI-related systems also emerge, the ethical considerations of analytical bias will also appear as critical, and ensure the transparency of the automated decision-making process to maintain the sense of fairness and responsibility.

The further evolution of real-time data analytics will play a significant role in the improvement of decision-making in various sectors. Additional studies to integrate other sectors of the economy into this research, such as manufacturing, logistics, and telecommunication, would assist in bringing a more detailed understanding of how real-time overwhelming data can achieve a balance of operations in various environments. The 5G and quantum computing of the new technology will enable processing of real-time data to be more convenient, facilitating faster and more accurate decision-making. Addressing the challenges of data privacy and security will help ensure that the real-time data solutions are utilized ethically and responsibly, and this will generate trust and compliance in the different industries. When organizations adopt this and focus on multi-industry applications, they will have an opportunity to use real-time data analytics to enhance their efficiency, reduce costs, and make their processes more customer-centric. The future of real-time decision-making systems is in the synthesis of the best technologies, elucidation of secure structures, and constantly enhancing the quality of data. This current study shows that real-time information is not just a tool used to make better decisions but plays an important role in enabling all businesses to be more successful and creative.

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