

Big Data at Maybank: Characteristics, Implementation, and Key Challenges

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Abstract: In today's digital age, big data and analytics have become essential instruments in the banking industry. This case study aims to understand the characteristics, implementation, and challenges of big data in the banking industry specifically focuses on Maybank. This paper begins with a discussion of the characteristics of big data (seven 7's) as applied in Maybank. Then, the six phases of big data are discussed. Throughout the six phases, Maybank effectively uses them to enhance customer satisfaction and optimize decision-making. Next, the usage and the necessity of big data software is justified through its alignment with both organizational needs and national initiatives. From an operational perspective, big data software solves issues such as handling huge data volume and real-time processing. Besides, this expenditure is in line with Malaysia's Budget 2025 policies that support digital transformation, demonstrating the necessity of big data software implementation in Maybank. The paper also addresses key challenges associated with big data that focus on data security and privacy risks, complex data management needs, talent shortages, high costs, and the need for cultural shifts. By understanding the characteristics, implementation and challenges, Maybank can strategically utilize big data to improve customer relationships and position itself as a leader in the banking sector.

Keywords: Big Data; Big Data Characteristics; Big Data Software; Banking Industry; Maybank; Implementation; Challenges.

1. BACKGROUND STUDY

In today's rapidly evolving digital landscape, big data analytics remains the most critical factor distinguishing the market leaders from the ones following the trends across all the industries, with the banking sector being one of the most prominent. The use of bank services becoming more and more digitalized forces the providers of these services to constantly improve the technology level, match the consumers' constantly changing expectations, and global operational efficiency [1]. The banking milieu is witnessing increasing rivalry with fintech firms, more serious regulatory obligations, and the spread of cyber risks. Thus, leveraging big data is no longer just a competitive advantage but a necessity for traditional banks to stay relevant.

Maybank, officially known as Malayan Banking Berhad, is one of Southeast Asia's largest financial services groups. Established in 1960, Maybank was the first homegrown bank to serve the nation, and by 1970 it expanded its activities internationally. Ranging from 1990 to the 2000s, Maybank began its expansion as well as the diversification of the services offered. New services including Investment Banking and Islamic Banking were launched. More recently though, Maybank has emphasized digital transformation as their chief priority. In 2022, Maybank launched the M25+ corporate strategy which is a digitalization strategy aiming to enhance growth by integrating into the current ecosystem of banking [1]. Such strategies are aimed at enhancing customer satisfaction through the use of digital platforms that are in sync with the prevailing trends in banking so as to not only grow the business but grow it sustainably.

In 2023, Maybank tops the ranking in Malaysia in total assets, total customer deposits, total gross loans, total net profit, and total CETI Capital Ratio. Maybank in some years evolved from a minor banking institution into one of the leading banks of SE Asia. It also shows the fact that the bank is able to respond to the ever-evolving banking environment [2]. However, in an environment where consumers increasingly demand instant, personalized, and seamless banking services, the need for continuous innovation remains crucial.

The importance of this research lies in the intersection of banking, technology, and data analytics. Maybank's strategic focus on big data is not merely a response to market competition but a critical enabler for sustaining its growth in a technology-driven environment. In a recent report, Maybank unveiled that a whopping 77% of their M25+ investment is directed toward the digital solutions and technology infrastructure sector, subsequent to which, hyper-personalization is the outcome expected [2]. These include advancing its data infrastructure, AI and machine learning, and refining its technology stack with a focus on cybersecurity [3]. As banks worldwide transition to digital platforms, the ability to derive actionable insights from data becomes a critical

factor for success. Such initiatives are crucial, not only for improving customer retention, but also for enhancing competitiveness in an industry where there is a growing expectation for timely, tailored, and smooth provision of services.

Understanding how Maybank leverages big data offers valuable insights for stakeholders, including banking professionals, policymakers, and academic researchers. For example, the data strategy of Maybank can be seen as a good practice by other banks in the region seeking to improve their data policy. They may better appreciate the regulatory challenges posed by the digitalization of banking [1], whereas practitioners may study how big data can be used in enhancing customer satisfaction, mitigating risks, and improving bottom lines.

It is important to note that although Maybank has made an enormous amount of investment in changing the form of its operations, the understanding of the strategic value of big data for business purposes is still in its infancy. Areas of customer personalization, fraud detection, and operational efficiency have featured in the literature, but only scant references have been made in Southeast Asia. While Maybank's M25+ strategy highlights digital investments, there is a lack of empirical evidence on the effectiveness of these initiatives in achieving desired business results. This research seeks to bridge this gap by providing an in-depth analysis of Maybank's use of big data to enhance its competitive edge.

The objectives of this research are to analyze the key characteristics of big data utilized by Maybank and understand the six phases of big data. Next, this study also aims to identify the necessity of big data software and challenges in implementing big data strategies within the banking industry.

The study focuses on Maybank's operations within Malaysia, with a particular emphasis on the data characteristics, six phases of big data, use of big data software and the challenges faced. The research is limited to analyzing publicly available reports and literature related to Maybank's use of big data. The research will rely solely on publicly available data and official reports due to the proprietary nature of internal banking data. Therefore, the study will not cover the bank's internal decision-making processes or proprietary technologies that are not disclosed in public sources.

2. CHARACTERISTICS OF BIG DATA

Big data has the capability to capture, store and analyze large, complex and ever-changing datasets to draw conclusions or take action. These datasets can be described by the 7Vs of Big Data: Volume, Variety, Velocity, Veracity, Variability, Visualization, and Value as depicted in Fig. 1. It is worth noting that each of these characteristics is important in determining what the business can effectively do with the data. These characteristics form the basis for the application of big data in the banking, healthcare, and e-commerce industries, enabling these sectors to be data driven and sustain competitiveness in the ever-changing environment [4].

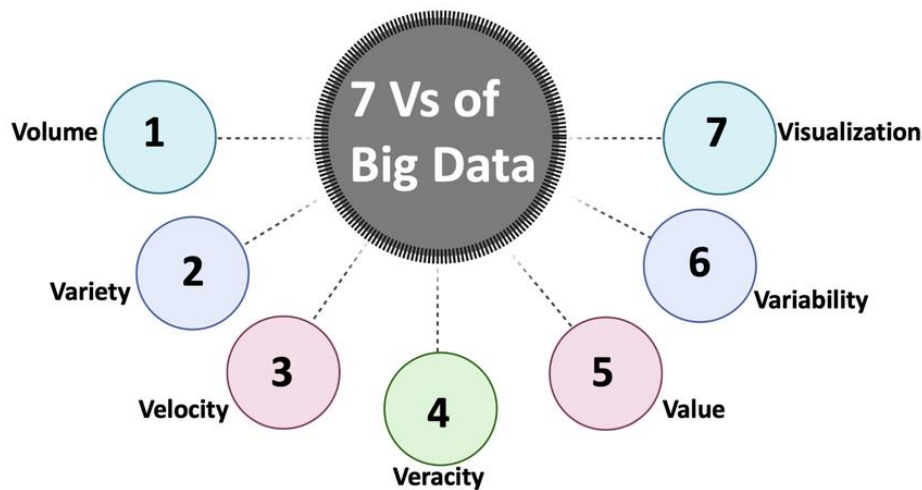


Fig. 1 7Vs of big data characteristics. Adopting figure from [5]

2.1 Volume

Data volume in the banking industry is generally massive. As one of the largest banks in Southeast Asia, Maybank manages an enormous amount of data daily. The data recorded not only includes transaction histories, but also customer interactions across physical and digital platforms. Maybank processes a gigantic number of transactions daily that includes deposits, withdrawals, fund transfers, and payments. Each transaction generates data such as timestamps, amounts, account details, transaction type, and locations, altogether these details accumulate and build up the big data. As more digital applications are introduced by Maybank, these apps such as Maybank2u and MAE by Maybank2u as illustrated in Fig. 2, which are used by millions of users for everyday transactions, cause the data volume to spike significantly. On these platforms, every login, transaction, or interaction will be recorded, creating an extensive data trail.



Fig. 2 Examples of the digital applications introduced by Maybank. From left to right, MAE by Maybank2u and Maybank QR Pay.
Adopting figure from [6]

Maybank Integrated Report 2023 mentioned that the bank served over 16 million retail, non-retail and corporate customers across its ASEAN market. Over RM1.1 trillion in transactions were completed by Maybank via its digital platform in fiscal year 2023 throughout ASEAN, including Malaysia, Singapore, Indonesia, and Cambodia [2]. The massive transaction volume indicates the need for proper storage capacity and infrastructure to handle the data.

[7] argues that effective management includes employing scalable storage and advanced infrastructure, which deals with the data created after the effective management. When considering the creation of new products, data analytics allows the establishment of core interrelations between multiple parameters. These allow banks, in essence, to enter new markets while also dominating all existing ones. It thus stands to reason why Maybank considers the construction of new big data storage systems including cloud storage as pertinent.

2.2 Variety

Variety indicates the different types and format of data. Maybank's data comes from different sources and consists of both structured and unstructured data. Some examples of structured data include:

- Account details
- Transaction records
- Financial statements.

Unstructured data lacks predefined format and is more challenging for analysis. Maybank collects data on customer interactions across its call centers, and digital channels like the Maybank website, MAE app and Maybank Wealth to be used for analysis. Examples of unstructured data are as below:

- Customer emails and chat logs
- Social media interactions
- Branch and call center notes
- Web browsing behavior.

In its report, Maybank revealed their continued strategy in digitalization as their effort for better customer centricity. They have onboarded more than 12 million active retail customers onto their feature store [2]. Tracking customer interactions on its digital platform helps Maybank to understand customer behavior and assess which app features are most popular. With the right big data analytics technique, insightful information can be derived from the data to be used for utilization of the tailored product offerings to meet individual needs effectively.

Due to the substantial volume of unstructured data that exists within organizations, NLP and machine learning must be employed as more advanced techniques [8]. When integrating structured and unstructured data, it helps to uncover customer needs and evaluate popular app functionalities that are worked out in the process of designing tailored banking products. By embracing variety, Maybank strengthens its customer-centric strategy and enhances the value derived from its big data initiatives.

2.3 Velocity

Every day, the banking sector generates a large volume of new data at a very quick rate. Maybank must process the new data swiftly to meet the real-time requirements. For example, identify fraud and suspicious activity instantly. In a scenario where a customer's credit card is used simultaneously in different locations or shows unusual spending patterns, the system must flag these transactions immediately through platforms such as MAE or Maybank2u, protecting both customers and the bank from potential fraud [4]. Otherwise, it might lead to significant losses and even reputational damage to the bank for its delayed response [9].

It is challenging to process data from multiple channels simultaneously, including mobile apps, internet banking, ATMs, and

point-of-sale terminals, while maintaining system performance and security standards [3]. To ensure smooth real-time daily operation, Maybank requires advanced infrastructure and technology that can quickly process big data. Maybank's dedication to real-time data processing to guarantee that customers receive changes instantly is undoubtedly demonstrated by the real-time in-app notifications on apps like MAE.

[10] discussed how real time data processing is perhaps the most relevant centers for competitive advantage in any industry where swift responses are a must. Real time data analytic infrastructure is in many ways guaranteeing Maybank to manage and maintain all activities regarding the security aspects, expanding possibilities to optimize user experiences, which is extremely important to comply with regulations.

2.4 Veracity

Veracity refers to the accuracy and reliability of the data. In the banking industry, high-quality quality data is essential to derive useful insight and ensure the correct decision is made. Bank relies on data to make decisions such as loan approval, fraud detection and risk assessment. If the data is not accurate, surely, it will influence the result of the analysis, causing the data-driven decision to turn out to be an ineffective one [11].

Maybank employs stringent data validation processes and advanced analytics tools to maintain high data quality. For example, cross-verification of customer transaction data occurs through numerous barriers of encryption and authentication in order to avoid violation of whatever terms and agreements [12]. Additionally, machine learning is utilized in fraud detection systems, ensuring insights are accurate and decisions are based on true facts [9].

[13] highlighted that poor data quality will cost organizations an average of \$12.9 million annually. Therefore, it is evident that the discrepancy of the data would lead to huge losses for the company. Maybank has a strong focus on data veracity, which means that certain risks are reduced because the dataset is very reliable. Additionally, appropriate data makes it easier for the bank to assimilate personalization and attend to regulation, compliance with the standards, and the bank's clients' wants.

2.5 Variability

Variability reflects the inconsistent nature of data. This characteristic appears to be a very challenging part. Data volumes and processing needs are influenced by seasonal trends, economic conditions, and unexpected events. In the context of Maybank, the variability of data is driven by seasonal event such as the spike in transaction during Malaysian holidays like Hari Raya when customers send money to family or spend for festive preparation. As reported by [14], Maybank expected a spike of 30% in e-Duit Raya transaction during Hari Raya, as a trend driven by the shift of digital payment due to Covid-19, which is also a result of preference for digital over traditional payments.

However, variability must be dealt with by having appropriate systems capable of scaling in times of drastic increase in data volume and processing requirements. Maybank for instance utilizes cloud-based resources which allows its operations to remain seamless even in the busy seasons where core activities are heightened.

Big data can most of the time be considered a double-edged sword which comes at risk of business activity. Variability is one of the most challenging aspects of big data, requiring organizations to adopt flexible and adaptive strategies [15]. Maybank's ability to manage data variability ensures that it can deliver uninterrupted services, even during high-demand periods, thereby maintaining customer satisfaction and operational efficiency.

2.6 Visualization

A good representation of data aids in understanding complex trends and data. Visualization reveals the underlying information for the decision-maker to do real-time decision-making. For example, bank uses data visualization to identify risks associated with loan approval [16]

Visualization allows the bank to identify patterns, trends, and outliers in customer behavior and financial performance. Predictive analytics can therefore be performed to forecast market conditions and risks [17]. Visualizations also facilitate the communication of complex data-driven insights to executives and stakeholders. Banks are using advanced visualization to create dashboards that display real-time data analytics, allowing for better monitoring of financial performance and customer behavior [18].

Effective visualizations improve decision-making by giving complex data a clear and understandable depiction, as [19] proposes. Stakeholders may track important indicators, spot trends, and evaluate the success of marketing efforts with Maybank's dashboards. Maybank increases operational effectiveness and its capacity to convey findings to executives and clients by utilizing visualization.

2.7 Value

Value is the ultimate goal of doing big data analytics from the perspective of the bank, as it is utterly important to make profit for all business operators. Big data with the right data can be analyzed to yield insights to help in decision-making. Using big data, Maybank can generate significant business value in the different range of financial services they offer, which includes wealth management, asset management, retail banking, investment banking, and digital banking [4].

Big data analysis allows Maybank to understand their customer characteristics and enable segmentation based on the data. Hence, this can improve customer experience through personalized products and can increase customer loyalty [20]. In the era where social media and internet usage has been a significant part of our daily life, analyzing data from these sources is essential for banks to align their offerings with current market trends utilizing big data analysis and management [21]. To achieve business excellence, it's crucial for Maybank to stay in sync with these trends, particularly to attract the attention of younger, digitally engaged customers. Effective online marketing can capture the interest of this audience, setting Maybank's products apart from competitors [xx]. By leveraging big data, Maybank can make data-driven decisions that not only enhance business insight but also drive higher income and sustainable growth in a competitive market [20].

In conclusion, the 7Vs of Big Data—Volume, Variety, Velocity, Veracity, Variability, Visualization, and Value—provide a comprehensive framework for understanding and managing the complexities of big data in today's digital age. Each characteristic plays a pivotal role in shaping how organizations like Maybank harness the power of data to optimize operations, improve customer experiences, and drive sustainable growth [[17].

3. SIX PHASES OF BIG DATA

The six phases of big data include Data generation, Data acquisition, Data storage, Data analysis, Data Visualization or interpretation, and Decision making.



Figure 3: Six phases of Big Data

Phase 1: Data generation

Data generation is the process of creating data through various sources. Large volumes of structured, semi-structured, and unstructured data are commonly produced by big data sources like logs, IoT devices, social media platforms, and others. [4] highlighted that the introduction of social media and the Internet of Things resulted in a huge increase in the volume and variety of data collection. The rapid growth of big data has proved the essential need for the development of scalable solutions for data collection and storage. Meanwhile, [22] discussed the technical challenges in managing this exponential data growth. Both studies emphasize the necessity for robust systems capable of handling multiple data sources while ensuring quality and consistency.

As [23] stated, there are 3 potential sources of big data for banks which are offline banking mode, online banking mode and social banking activity. The most common mode is offline banking mode which is when customers visit the bank physically. For example, the basic personal data is required for opening a savings account such as name, age, Identification Card (IC) number, occupation, etc. Online banking in Maybank involves the Maybank2U website and the MAE by Maybank app. These platforms monitor user activity, including login frequency, transaction types, spending patterns, and interaction preferences will cause large amounts of data is generated. Social banking involves conducting transactions through social networking media like Facebook.[24] indicated that IoT (Internet of Things) in banking includes Mobile Banking, Virtual Money, Personal Financial Management (PFM), Know Your Customer (KYC) and Cyber Criminality. These transactional data provide banks with real-time insights into customer behaviors, enabling them to identify trends in spending, savings, and loan usage.

Phase 2: Data acquisition

Data acquisition is the critical process of gathering and transmitting raw data from numerous sources to centralized systems. This phase consists of data input via APIs, real-time streaming, or batch uploads, followed by preprocessing to improve data quality.[25] underlined the relevance of real-time data capture solutions such as Apache Kafka and Flume in ensuring consistency in high-volume data streams. [11] emphasized the significance of enterprise-class systems for managing streaming data pipelines, as well as scalable solutions that interact easily with current infrastructures. These findings showed the need for effective acquisition techniques in preparing data for the following phases.

During this phase, the appropriate security and protection are also important to acquire reliable data and additional security measures are also necessary to keep data from being released [26]. During making online bank transactions, the most known authentication procedure for Maybank is Secure2U. Secure2u pairs our device with a Maybank2u account, offering an extra level of security as all transactions performed can only be authorized on our registered device which reduces our exposure to SMS TAC fraud. The Maybank website also indicated that encryption functions are used to shield the customer's personal information and transactions that convert the information into code that only bank can read. For data transmission, data center interconnect (DCI) technology allows efficient and secure data transmission between its data centers. This technology helps with smooth data transfer and collaboration for Maybank's operational and customer service requirements throughout its branches worldwide. Data centers can manage Maybank's real-time transaction data and ensure system uptime for continuous banking services through DCI technology, which typically offers high-speed, low-latency connections. This is crucial in the competitive banking climate of today.

Phase 3: Data storage

Data storage aims to organize and protect large amounts of information effectively while also being cost-efficient and scalable. For handling big data, distributed storage systems like Hadoop HDFS and cloud platforms such as Amazon S3 are common choices. [27] emphasized how crucial these distributed systems are for managing extremely large datasets, particularly because of their ability to handle faults and grow as needed. Additionally, [28] explore how tools like MapReduce can improve distributed storage, finding a good balance between how much data can be stored and how quickly it can be processed.

Information obtained must be safely stored and shielded from potential dangers during the data storage phase. To ensure data integrity and confidentiality, effective strategies include the use of encryption, access controls, and physical security mechanisms. In addition, any sensitive information that is accidentally obtained is also immediately removed [26]. Based on research from [29], a SQL database can be used if the organization places more priority on data standardization and consistency while NoSQL is used when the business has a lot of unstructured data and data availability is a top priority. Maybank can use SQL to support structured data storage such as customer account information, transaction details, and financial statements to ensure high integrity. Maybank also can use NoSQL databases like MongoDB, which allow for greater flexibility when processing large volumes of data. SQL performs better than NoSQL in a small database while NoSQL is better for big data analytics. [30] stated that cloud computing will be a key component of the banking sector's future as technology develops and the banking sector will be able to fully utilize cloud computing's potential to improve banking services' efficiency, scalability, and innovation. Hence, Maybank can also use cloud storage solution to support scalability, enabling real-time data analysis and disaster recovery measures.

Phase 4: Data analysis

Data analysis is the process of identifying patterns, insights, and relationships in datasets using statistical analysis, machine learning, and deep learning. Raw data can be turned into important information during this stage, which is essential for applications that use big datasets because it transforms a lot of unprocessed data into insightful knowledge that helps in decision-making. Data analysis was defined by [15] as a "value generator." This demonstrated how crucial it is for strategic decision-making and predictive modeling. Additionally, [8] investigated approaches that handle the difficulties in handling data, such as text and sentiment analysis.

Maybank uses advanced data analytics to better understand client behavior, control risk, and enhance customer experience. Based on McKinsey's 2021 findings that customer-centric data analytics may greatly increase happiness and retention, the bank can produce insights that promote customer interaction and optimize marketing efforts [31]. Maybank can adjust communications, such loan reminders and promotional materials, to match consumer preferences about frequency and time by using predictive analytics. Furthermore, research like KPMG's 2020 Financial Services Report emphasizes how banks' risk analytics improve validity to economic swings and promote the accuracy of credit scoring. To reduce possible losses, Maybank uses these concepts by evaluating trustworthiness and market movements. This data-driven approach demonstrates Maybank's dedication to providing individualized services and effective risk management in the cutthroat digital market of today.

Phase 5: Data Visualization or interpretation

Data visualization is to show analytical conclusions in understandable and usable trends, may through dashboards, graphs, or interactive tools. This stage is critical for successfully communicating insights to stakeholders.[32] state that well-designed visualizations bridge the gap between raw data and decision-making by allowing for intuitive comprehension of data linkages. [33] underline the importance of storytelling in visualization, stating that incorporating context and narrative increases stakeholder involvement and comprehension.

As [34]showed, use appropriate graphical methods in analytical applications that are tailored to the data being analyzed and that consider the needs of managers and can minimize the time currently required to retrieve the required information. Visualization provides real-time alerts on cybersecurity threats from Maybank own security system which help to monitor and respond to

abnormal info quickly. Visualization also enhances customer experience by enabling Maybank teams to track metrics like app response times on Maybank2U which allow responses to issues such as app performance. Furthermore, data interpretation for tools like MAE helps Maybank understand customer preferences and inform service enhancements. Data interpretation like pie charts for whole month money transactions in the MAE app also helps customers to directly understand the flow of money within the month.

Phase 6: Decision making

The last stage of the big data process is decision making, which involves using insights to solve issues, optimize operations, or lead strategic activities. This step converts analysis into practical results, completing the data lifecycle. [35] stated that adopting data-driven decision-making shows considerable increases in efficiency and competitiveness. [36] described the practical difficulties of integrating analytics into processes, but they also emphasize the long-term benefits of utilizing data to influence choices. Finally, this phase guarantees that the benefits of big data can be utilized in real-world applications.

Big data has significantly enhanced Maybank's decision-making process by transforming raw data into actionable insights that support various strategic initiatives. By analyzing customer behavior and transaction data, Maybank provides personalized services to improve customer satisfaction in a competitive digital environment. Predictive analytics plays a vital role in risk management, accurately assessing credit risk and identifying high-risk customers, thereby improving lending decisions and minimizing potential losses. In addition, real-time monitoring of operational metrics, especially on platforms such as Maybank2U, enables the bank to proactively resolve issues and ensure high levels of service levels and operational efficiency [2], [18], [20]. The adoption of big data analytics can lead to more accurate decisions, improved customer satisfaction, and enhanced operational efficiency, which is critical to achieving the strategic goals of the banking industry.

4. THE NECESSITY OF BIG DATA SOFTWARE

To address the necessities of big data at Maybank, each of these seven areas—handling large volumes of data, enhanced decision-making, real-time data processing, data variety and integration, improving data accuracy and veracity, cost efficiency, and competitive advantage—serves as a pillar in the bank's broader digital strategy. These aspects align with Maybank's strategic focus areas and growth opportunities, as well as with government initiatives like Malaysia's Budget 2025, which emphasizes the importance of digital transformation and cost-effective, targeted solutions.

This analysis will utilize Malaysia's Budget 2025 to demonstrate how the necessities of big data at Maybank align with and support the latest trends promoted by the government. Budget 2025 emphasizes digital transformation, targeted resource allocation, and cost efficiency, offering incentives for companies that invest in digital systems, such as e-invoicing, and that adopt targeted subsidy rationalizations. By integrating these government-backed initiatives, Maybank's big data strategy not only strengthens its capacity to manage and analyze data effectively but also ensures that the bank remains in line with national priorities. Supported by the Department of Communications and Digital Technologies, which champions initiatives for a tech-enabled economy, Maybank's approach enables the bank to adopt forward-thinking solutions that improve operational efficiency and enhance customer experience. This alignment enables Maybank to maintain its leadership in the digital banking sector while actively contributing to Malaysia's vision of a more data-driven and efficient economy.

4.1 Handling Large Volumes of Data

With millions of transactions occurring daily, Maybank faces the challenge of managing massive amounts of data efficiently. In today's digital age, this isn't just about storage; it's about ensuring quick access, security, and the ability to derive insights from data in ways that improve the customer experience. Maybank's adoption of cloud-based solutions and scalable storage technologies is essential to tackle this volume. Cloud technologies as shown in Fig. 1 allow the bank to store and process large datasets without compromising performance or flexibility, which is especially crucial as customer interactions move increasingly online. Furthermore, Malaysia's Budget 2025 emphasizes the importance of digital investments, offering incentives for businesses that adopt advanced digital systems, such as e-invoicing. This aligns with Maybank's drive to handle data at scale, ensuring that as data volumes grow, the bank can still provide seamless, secure, and efficient services.



Fig. 1 Cloud computing with IoT connected banking platform. Adopting figure from [37]

4.2 Enhanced Decision-Making

Maybank's data-driven approach to decision-making is one of its key advantages in the competitive banking sector. With access to extensive data on customer interactions and market trends as shown in Fig. 2, Maybank can leverage this information to make smarter, more informed decisions. This approach allows the bank to tailor its services to customer needs, predict future trends, and mitigate risks more effectively. By utilizing artificial intelligence (AI) and machine learning, Maybank is able to analyze patterns in customer data, which helps them to personalize services and anticipate financial needs before customers even voice them. This aligns with the Malaysian government's Budget 2025 approach, where targeted subsidy rationalization is used to allocate resources more effectively based on real-time data. Just as the government uses data to ensure that subsidies reach the right people, Maybank uses customer data to ensure that products and services are tailored and relevant, fostering customer loyalty and increasing revenue.

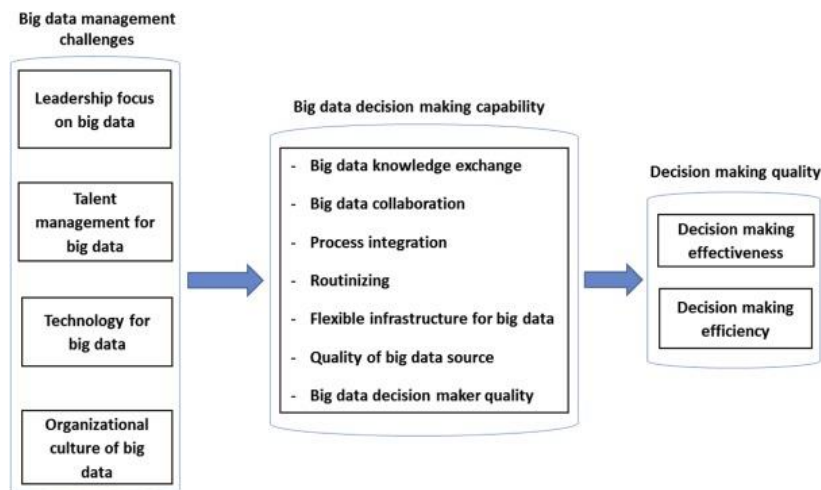


Fig. 2 Big data management and decision-making quality framework. Adopting figure from [38]

4.3 Real-Time Data Processing

In an era of instant gratification, real-time data processing has become essential in banking, especially for a major institution like Maybank. Immediate data access as shown in Fig. 3 allows the bank to offer quick transactions, real-time fraud detection, and instant responses to customer inquiries, all of which are vital for a positive customer experience. Given the rise of mobile banking and digital payments, customers now expect swift, seamless interactions with their bank. Maybank has invested in advanced systems capable of analyzing data in real-time, ensuring it can meet customer demands as they arise. This focus on immediacy mirrors the government's targeted subsidy strategies in Budget 2025, which will begin adjusting the RON95 fuel subsidy based on real-time consumption patterns. In the same way, Maybank's real-time processing capabilities enable it to react swiftly to changes in customer behavior, ensuring they are always one step ahead in providing timely and relevant services.

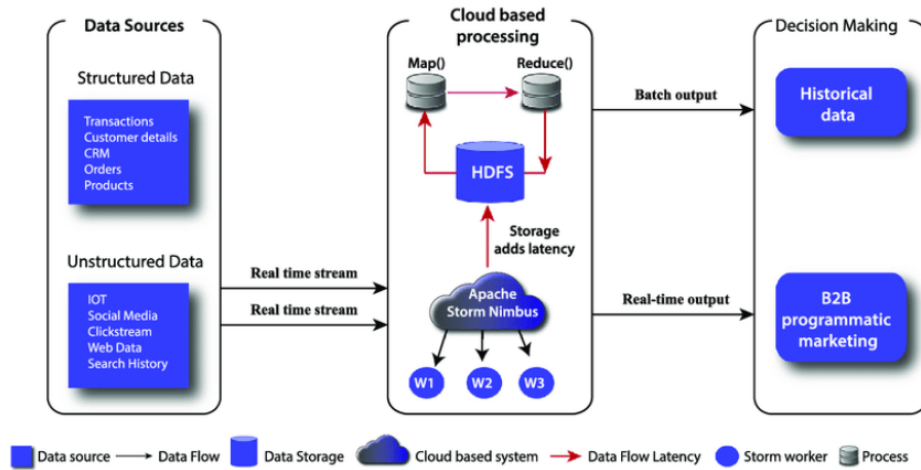


Fig. 3 Real-time data processing. Adopting figure from [39]

4.4 Data Variety and Integration

The diversity of data sources presents a unique challenge for Maybank as it seeks to develop a comprehensive understanding of its customers. Traditionally, banking data was largely limited to transaction records. However, Maybank now collects data from a wide range of touchpoints, including online interactions, social media, and customer feedback surveys. This variety enriches customer profiles and enables a more holistic view of customer behavior, though it requires sophisticated systems for integration and analysis. The MAE app plays a pivotal role in this data integration effort, seamlessly combining transaction data with insights from customer spending habits, budgeting needs, and lifestyle preferences, all in a single platform. With features like expense tracking, financial planning tools, and enhanced exchange rates for international transactions as shown in Fig. 4, the MAE app allows Maybank to provide personalized services that cater to individual customer needs. This data integration strategy aligns well with the government's Budget 2025 initiative, which encourages the adoption of digital tools like e-invoicing to simplify data handling. By leveraging integrated data within MAE, Maybank not only improves operational efficiency but also enhances its ability to deliver customized banking solutions that resonate with modern digital lifestyles. This focus on data variety and integration ensures that Maybank remains agile in a competitive landscape, reinforcing its commitment to customer-centric innovations.

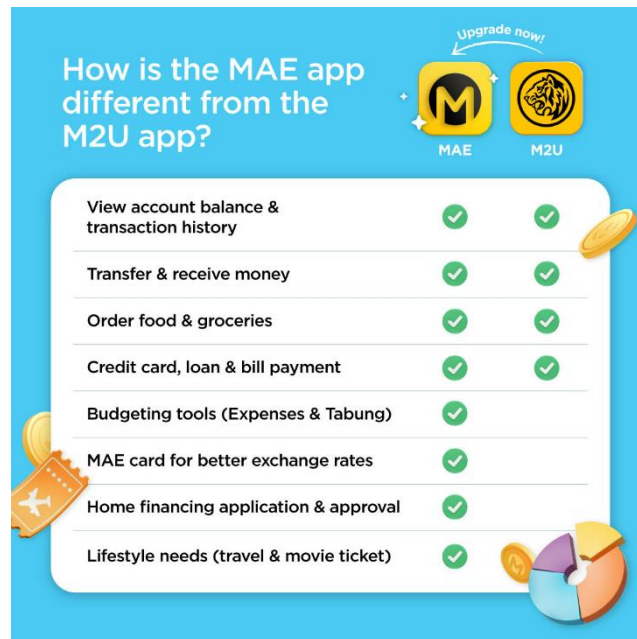


Fig. 4 Functionalities of MAE app vs M2U app. Adopting figure from [6].

4.5 Improving Data Accuracy and Veracity

Maybank's emphasis on data accuracy is reinforced through AI-driven data quality management, which plays a vital role in maintaining customer trust in the sensitive banking sector. Using machine learning (ML) algorithms, Maybank can identify

patterns, detect anomalies, and automate error rectification, ensuring a high standard of data accuracy across operations. For instance, AI aids in spotting duplicate records or inconsistencies in real-time, reducing errors in financial transactions and customer records. This automation streamlines workflows and enables Maybank to respond swiftly to data discrepancies, enhancing both operational efficiency and reliability. In the financial industry, AI's role extends beyond error detection; it also strengthens compliance and security by tracking data lineage and enforcing data quality standards. This is especially crucial as banks deal with vast datasets that require precise handling for regulatory compliance and customer service excellence. Enhanced data quality through AI not only reduces the risks of mismanagement but also cuts operational costs by minimizing the need for manual interventions. Furthermore, the importance of data accuracy aligns with initiatives in Malaysia's Budget 2025, where accurate data is critical to ensure subsidies reach intended beneficiaries. This parallel reflects Maybank's commitment to precision, as seen in government efforts to ensure public resources are used effectively. By maintaining stringent data quality, Maybank supports a trustworthy and customer-centered approach in its operations, setting a competitive edge in the financial industry.

4.6 Cost Efficiency

Digital transformation is often accompanied by significant costs, especially during initial implementation. However, by investing in automation, AI, and other digital solutions, Maybank can achieve long-term cost savings. Automation reduces the need for manual data processing, freeing up resources that can be redirected towards customer service or innovation. This focus on cost efficiency allows Maybank to offer competitive rates and improve profitability. Malaysia's Budget 2025 reflects similar thinking with its move towards targeted subsidies, which aims to reduce fiscal leakage and ensure resources are used more effectively. By strategically investing in technology as shown in Fig. 5, Maybank is not only reducing operational costs but also positioning itself to respond to market changes in a cost-effective manner, ensuring they can continue to deliver value to customers without unnecessary expenditure.

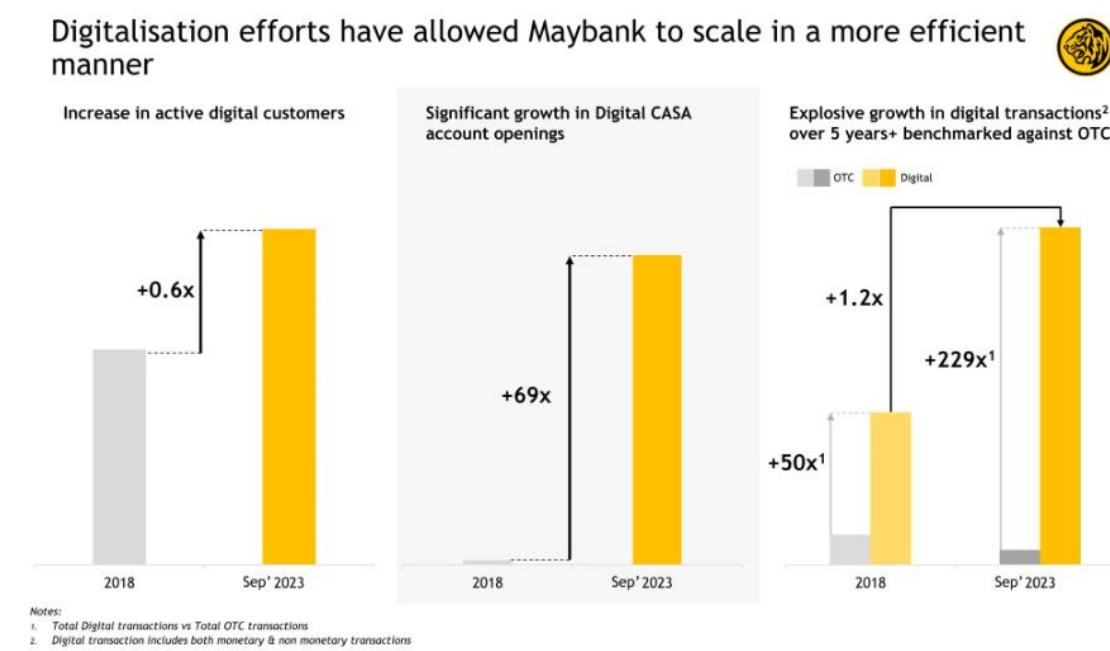


Fig. 5 Effect of Maybank's digital transformation from 2018 to 2023. Adopting figures from [40].

4.7 Competitive Advantage

In the rapidly evolving financial landscape, digital innovation has become a major driver of competitive advantage. For Maybank, investing in cutting-edge technology and data-driven customer solutions sets them apart from other players in the market. Maybank's focus on customer-centric services, such as mobile banking and AI-driven insights, reinforces its position as a leader in digital banking in Southeast Asia. By analyzing customer needs in real-time and offering tailored financial advice, Maybank ensures that it is not only meeting but exceeding customer expectations. This competitive positioning is similar to the government's approach to targeted subsidies, which allows it to maximize efficiency and minimize waste. Maybank's digital-first strategy, combined with a commitment to continuous improvement, enables it to stay ahead of competitors and adapt quickly to regulatory changes, solidifying its role as a leading financial institution in the region.

4.8 Summary

In summary, these seven strategic necessities—handling large volumes of data, enhanced decision-making, real-time processing, data variety and integration, data accuracy, cost efficiency, and competitive advantage—are not just operational requirements but integral to Maybank's digital growth. By focusing on these areas, Maybank is aligning with government initiatives,

embracing modern technology, and ensuring its long-term success in an increasingly digital banking landscape. Through careful planning and commitment to innovation, Maybank continues to lead as a modern financial powerhouse, ready to meet the challenges of today and tomorrow.

5. KEY OBSTACLES FOR BIG DATA SOLUTION

Although big data provides numerous advantages in Maybank, its implementation also presents several important obstacles that must be addressed.

One of the main obstacles with the implementation of big data is data security and privacy. The banking industry collects massive amounts of valuable and sensitive information such as credit histories, financial statements and income details [41]. The shift to big data has caused exponential growth in both structured and unstructured data. This growth has not only caused the complexity of data management, storage and security [42], [43] but also increased the risk of data breaches, compromises customer privacy and unauthorized access [43], [44]. These concerns are so significant that in one case the CEO in the banking industry expressed their concerns about using cloud-based services due to security risks [45]. The large databases of personal and financial information make banks become targets for cybercriminal attacks. As one of the largest banks in Malaysia, Malayan Banking Bhd (Maybank) experienced this first-hand when a listing on the dark web allegedly offered to sell the database that contained millions of its customer records [6]. Although Maybank confirmed that its systems remained secure and that customer information was fully protected, this incident highlighted the obstacles associated with big data in terms of sensitive information. Banks must establish and create a wide range of regulations in terms of adherence to internal data protection standards to maintain customer trust [44], [45]. In response to the data breach allegation in Maybank, the bank committed to increasing its security policies and implementing various countermeasures to authenticate transaction, such as Secure2u, MAE app security feature, Kill Switch and a cooling-off period for high-risk transactions [47].

Next, the obstacles to manage vast amounts of data generated from sources are noticeable in the banking industry, such as Maybank. Research by [1] and [45] showed the obstacles faced by the banking industry to integrate and migrate large data volumes. The large volume and rapid velocity of data generated in the banking industry is usually present in standard data processing. Moreover, the large volume of data can reduce data quality, as analysts are likely to encounter a significant amount of irrelevant and noisy data [5]. [48] emphasised that the large volume of data is not the primary challenge in the banking industry, but it is the high dimensionality of the dataset. High-dimensional datasets complicate analysis and make operational interpretation challenging. This will cause a delay in analysis and decision-making. To address these issues, it is important for the banking industry, such as Maybank, to implement robust data governance practices. Strong data governance practices will ensure that data is accurately managed, complete, and consistent throughout its lifecycle [42], [48]. Maybank is at risk of making flawed decisions which could affect its operation and customer relationships if they do not implement effective data management.

Besides that, there is a shortage of qualified professionals with expertise in big data analytics. Maybank has several ways to help detect and prevent fraud, such as real-time monitoring and push notifications in MAE apps to identify any irregular or unauthorized transactions [49]. In addition, Maybank optimized its customer experience with a new, simplified, personalized, and optimized user interface and experience (UI/UX) [50]. These optimisation and technologies depend on artificial intelligence (AI) and machine learning (ML) for effective data analysis. However, the banking industry currently faces obstacles to recruit and retain talent capable of leveraging these advanced technologies [41]. Reports by [51] indicated that there is a significant demand for big data talent skills in Malaysia's banking sector due to the rise of fintech and digital transformation. However, there is a noticeable talent shortage due to a lack of experienced talent to deal with strict criteria and regulations. Once talent is acquired, retention becomes another critical challenge. The banking industry in Malaysia experienced a significant rise in turnover rates from 7.4% in 2012 to 13.3% in 2013 despite salary increment [52]. Research by [52] showed that job satisfaction and stress significantly influence turnover intentions among banking employees in Malaysia. Banks should offer more attractive job enrichment, improve the working environment and minimize job stress to reduce turnover rate. [42] highlighted that banks can enhance their capabilities in big data and analytics by investing in training and development programs to cultivate a skilled workforce. This approach is essential as the banking industry continues to face obstacles in recruiting and retaining the right talent, especially in the digital landscape. As the demand for data professionals continues to rise, Maybank must compete with technology firms and startups that often offer more attractive compensation packages and work environments.

Organizational culture and structure also play a critical role in the successful implementation of big data. Maybank must foster a culture that embraces data-driven decision-making and innovation. This requires not only a shift in mindset among employees but also gaining top management support for big data initiatives [1], [3]. Management plays a key role in ensuring clear direction, efficient resource allocation, and effective communication with stakeholders regarding the outcome of assessments and the bank's digital transformation plan. Providing adequate training and education to employees further improves the likelihood of successful big data integration [42], [43]. Management support can help create an environment where employees feel empowered to embrace data analytics and contribute to the bank's overall objectives. Therefore, Maybank must adopt a more agile organizational structure that encourages cross-functional teams to collaborate on data projects. This can be facilitated by establishing interdisciplinary task forces or project teams that bring together diverse skill sets and perspectives. By fostering

collaboration, Maybank can enhance its ability to leverage big data insights effectively and drive innovation.

Last but not least, the implementation of big data analytics in the banking industry like Maybank involves significant costs. Banks must upgrade their existing IT systems to accommodate the vast amounts of data generated from various sources, including customer transactions, market analytics, and regulatory compliance [53]. These upgrades involve costs for data storage solutions, processing power, and network capabilities to ensure that data can be collected, stored, and analyzed efficiently. Banks should take consideration long-term costs associated with data management and storage and choose suitable vendors to integrate new big data management technologies [41]. The transition to cloud-based platform is also essential in terms of cost effectiveness [42]. Moreover, the recruitment and retention of professional talent in data analytics represents another significant cost for banks like Maybank. Banks must not only attract talent but also invest in development programs and offer competitive salaries and benefits packages. This investment is crucial to ensure the reduction of costs due to the high turnover rate, lack of professional talent and lack of productivity [52], [53]. Resistance to change can lead to additional costs if employees are not adequately prepared to embrace new technologies and processes.

In conclusion, data security and privacy risks, complex data management needs, talent shortages, high costs, and the need for cultural shifts are significant obstacles that must be addressed. By addressing these obstacles proactively, Maybank can position itself as a leader in the banking sector.

6. CONCLUSION

Big data analytics have proven essential in enhancing customer satisfaction, improving decision-making, and securing a competitive edge. Key concepts, including data volume, customer behavior insights, and service optimization, serve as cornerstones in this shift toward a more responsive and personalized banking experience. The seven core characteristics of big data—volume, variety, velocity, veracity, variability, visualization, and value—each play a distinct role in Maybank's data management. Through the strategic handling of these characteristics, Maybank effectively processes extensive datasets, integrates diverse data sources, and personalizes customer interactions to improve service quality.

Maybank's big data strategy is further illustrated through six distinct phases: data generation, acquisition, storage, analysis, visualization, and decision-making. These phases highlight the structured approach Maybank takes to manage and utilize data effectively. By following this phased approach, Maybank achieves real-time decision-making capabilities and gains insights that directly support its digital services, converting raw data into meaningful actions. However, implementing big data initiatives in banking brings its own set of challenges. Complex data security risks, privacy concerns, and high operational costs form the primary obstacles. Other issues, such as managing diverse data structures, ensuring data accuracy and governance, and attracting skilled professionals, present additional hurdles. Cultural adaptability within the organization, coupled with a skilled workforce, remains critical to overcoming these challenges.

In response, Maybank has adopted the M25+ strategy, designed to guide the bank's journey in digital transformation. The M25+ strategy emphasizes investments in artificial intelligence, machine learning, and cutting-edge data infrastructure, enhancing Maybank's digital offerings, especially through the MAE platform. MAE utilizes big data insights to provide real-time information, bolster fraud detection, and offer tailored services that significantly enrich the customer experience. This commitment to digital innovation aligns seamlessly with Malaysia's national objectives. Malaysia's Budget 2025 encourages the banking sector to adopt digital solutions, including cloud storage, real-time processing, and targeted subsidies, which complement Maybank's efforts to build a data-driven, digitally empowered financial ecosystem.

While Maybank progresses in its digital journey, other Malaysian banks, such as GX Bank and Boost Bank, demonstrate rapid advancements toward full digitalization. GX Bank and Boost Bank stand out as two of Malaysia's first fully digital banks, providing services exclusively through digital platforms without the need for physical branches. These digital-only banks rely extensively on big data, artificial intelligence, and machine learning to deliver a seamless and highly personalized experience for customers. Although Maybank operates a hybrid model, balancing digital and physical operations, its M25+ strategy and substantial investments in big data technology underscore a clear path toward expanded digitalization and reveal a strong commitment to adopting innovations similar to those of fully digital banks.

In today's banking industry, big data is fundamental for driving data-informed decisions, enhancing risk management, and personalizing customer service. As digital transformation becomes increasingly essential, big data will play an even greater role in shaping the banking landscape. Institutions like Maybank, GX Bank, and Boost Bank showcase how big data can redefine customer experiences and streamline operations, reinforcing its value as a pivotal asset in banking's future.

7. REFERENCES

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