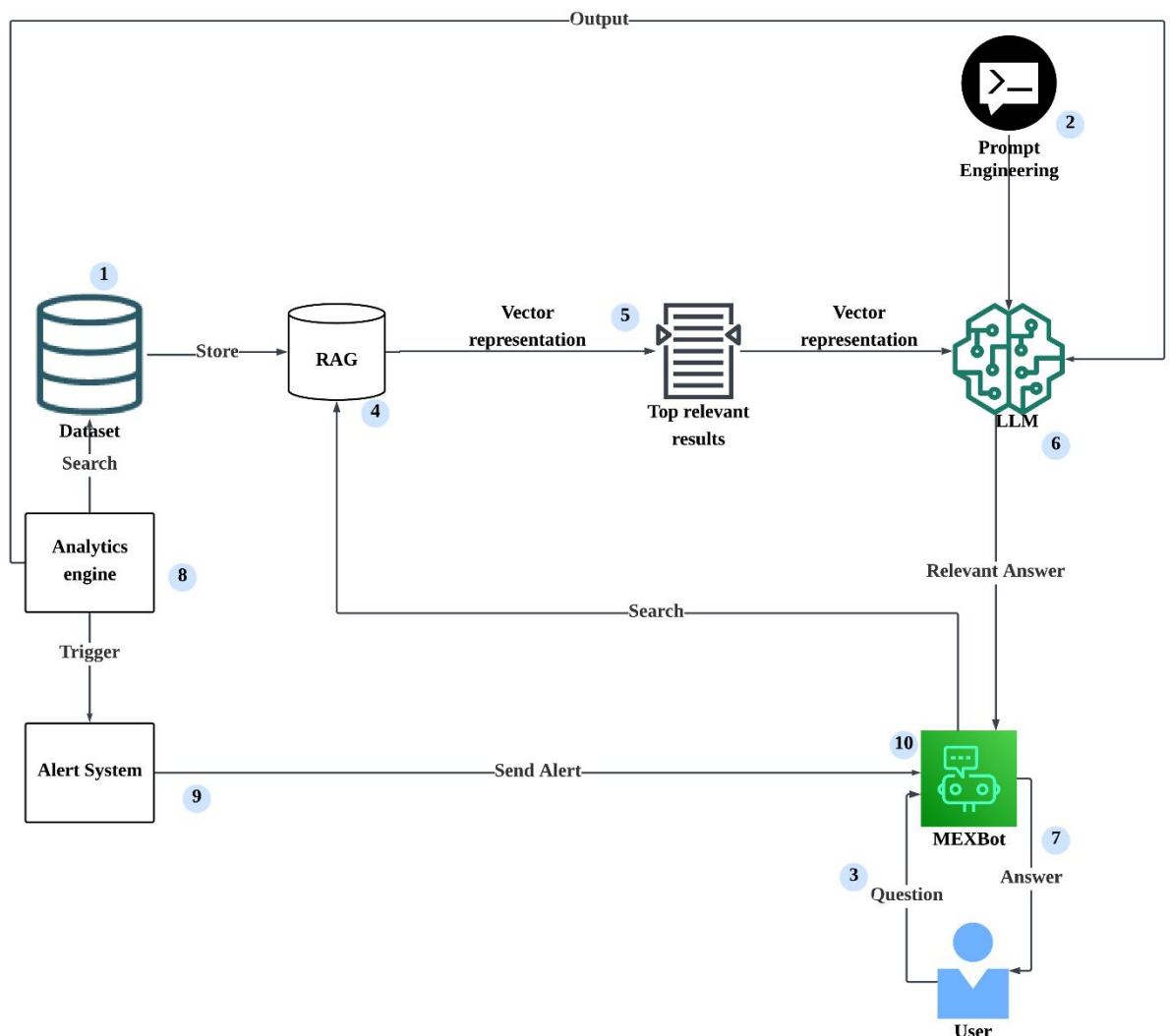


## Domain 3: Economic empowerment through AI (from Grab's vision + AI)

### Task 2: MEX Assistant – Insights

#### 1. Solution Architecture



#### Technical Infrastructure

- This architecture represents how MEXBot, a business assistant, uses Retrieval-Augmented Generation (RAG) and a Large Language Model (LLM) to respond intelligently to user queries using datasets.
- Backend services and APIs used
  1. The system ingests datasets including both structured (e.g., sales.csv, inventory.csv) and unstructured (e.g., merchant\_guides.txt) data.

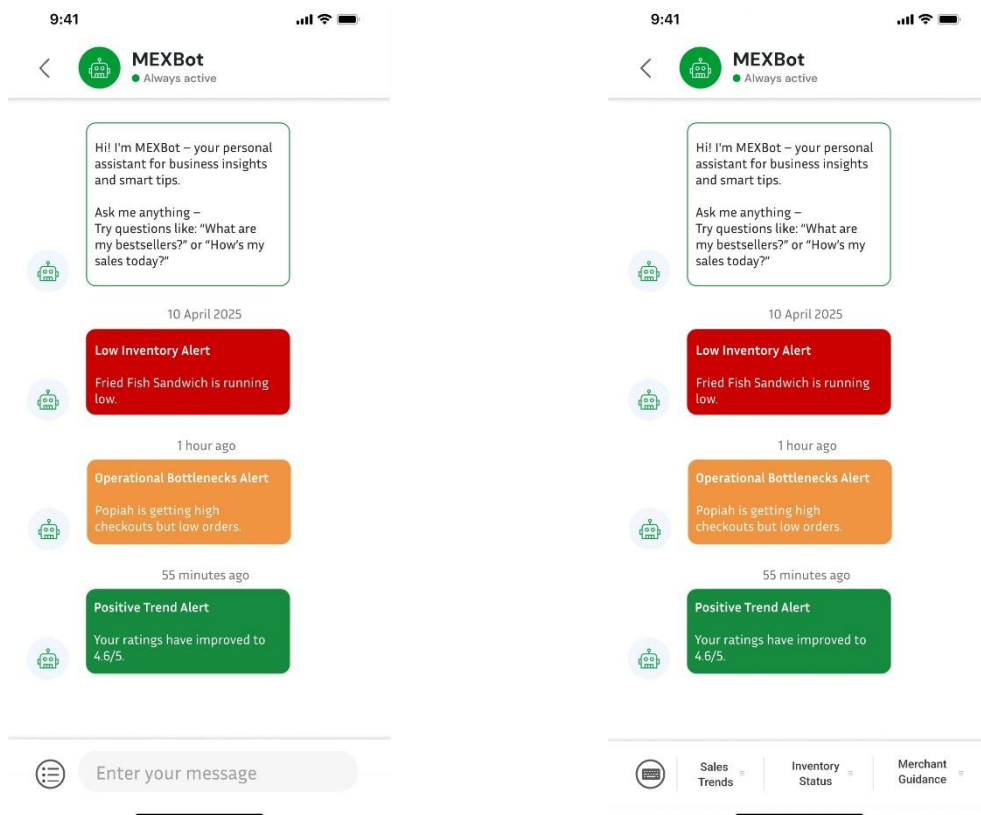
- Structured data is used by the Analytics Engine.
  - Unstructured text is converted into vectors using an embedding model and stored in the RAG vector store for semantic retrieval.
2. A structured prompt that guides the LLM to generate focused and relevant responses.
  3. The user asks a question through MEXBot, which forwards it to the backend for processing.
  4. For semantic questions, MEXBot sends the question to RAG, which searches the vector store for relevant content.
  5. RAG returns top relevant document chunks that match the query. These are used to build the final prompt for the LLM. For semantic questions, MEXBot sends the query to RAG, which searches the vector store for relevant content using similarity search.
  6. The prompt is sent to the LLM which generates a response.
  7. MEXBot receives the LLM's answer and presents it clearly to the user.
  8. For structured questions, the Analytics Engine processes relevant CSV datasets and performs KPI calculations (e.g., sales trends, top products, inventory levels). The Analytics Engine also runs periodically in the backend to monitor key metrics. If it detects anomalies or threshold breaches (e.g., low stock, sales drop), the results are passed to the Alert System, which then pushes notifications to MEXBot.
  9. The Alert System is triggered by flagged outputs from the Analytics Engine. When a KPI or threshold breach is detected, the Analytics Engine passes the result to the Alert System, which then pushes alerts to MEXBot.
  10. MEXBot receives the response or alert and presents it clearly to the user via the chat interface, using natural language and visual cues (e.g., colored tags for alerts). MEXBot also incorporates Intent Detection logic, which classifies the user's question into one of two types:
    - Structured intent → routed to the Analytics Engine. (e.g., "What are my sales this week?")
    - Open-ended/semantic intent → routed to the RAG + LLM pipeline. (e.g., "How can I improve delivery service?")

## Core Components

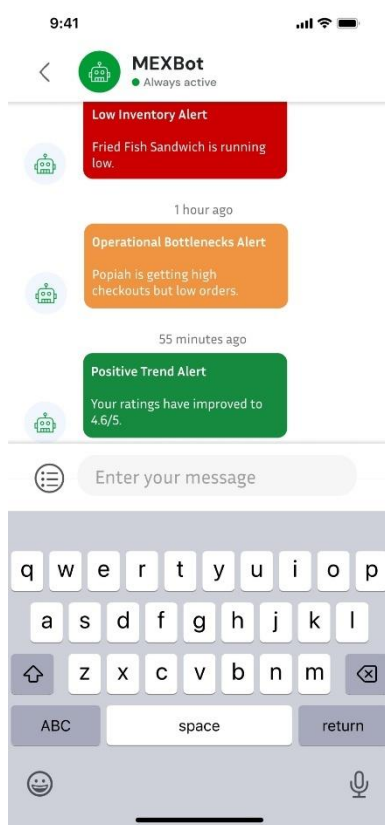
- Chat interface implementation details
  1. Message input bar + keyboard toggle
  2. Green Send button = submit query to MEXBot
  3. Message colors reflect alert priority (Red = critical, Orange = moderate, Green = positive)
  4. Accepts natural queries from users
  5. Sends the question to RAG
  6. Displays response from LLM
  7. Color-coded message bubbles indicate severity/priority
    - Red: Critical alert
    - Green: Positive update
    - Orange: Warning
- RAG + LLM Insight Engine
  1. RAG embeds structured data from your datasets
  2. LLM receives question + retrieved context
  3. Example flow:
    - User: “What sold the most today?”
    - RAG retrieves item frequency from today in orders.csv + items.csv
    - LLM forms response like: “Fried Chicken Bento – 42 sales today”
- Notification system design
  - Real-time alerts based on:
  - Delay thresholds (from time columns)
  - Stock-outs or high-performing items
  - Market events (holiday, weather)

## System Flow

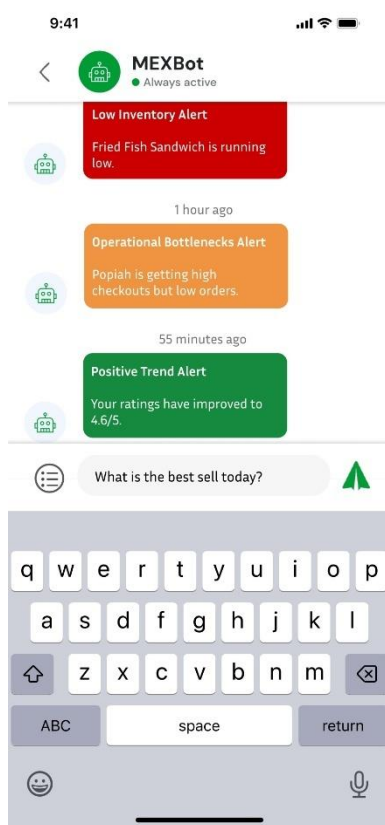
- User interaction sequences



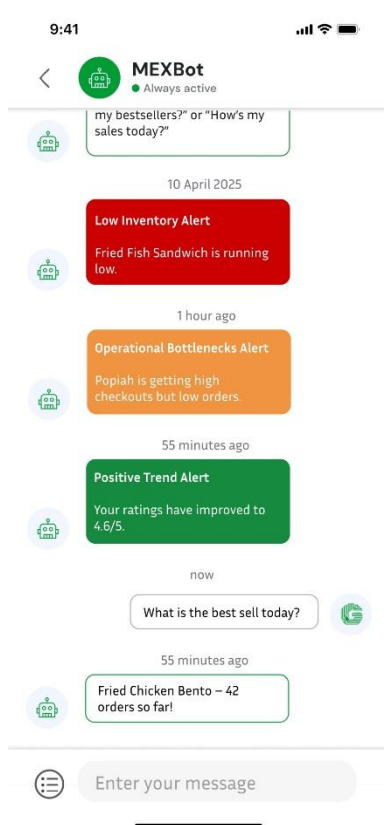
Users can chat directly with MEXBot, an AI assistant that provides real-time business insights. Automated alerts like inventory status and operational bottlenecks (low inventory, operational issues, or positive trends) are sent to the chat and remain visible so users can scroll back anytime. The color of the alert messages represents different alert stages: red for critical alerts, orange for moderate issues, and green for positive updates. This color helps users quickly recognize the urgency or positivity of each alert at a glance. When users tap the menu button, it expands into three quick-access options: Sales Trends, Inventory Status, and Merchant Guidance for easy navigation and deeper insights. When users tap the keyboard button, it expands into a message input bar, allowing them to type questions or commands directly to MEXBot for instant responses and insights.



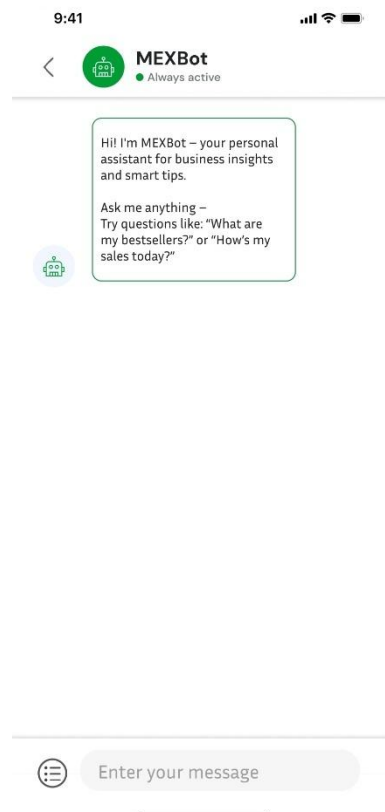
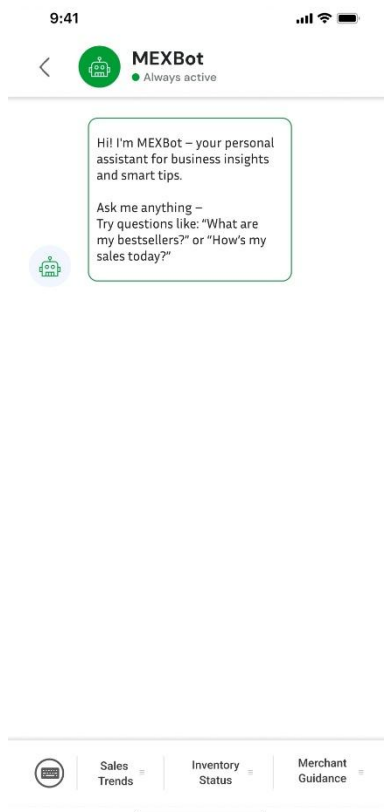
At the bottom, there's a message bar where users can type messages or questions directly to MEXBot, such as asking about merchant's recommendation. The keyboard is active, ready for input, enabling real-time, conversational interaction.



This page shows the MEXBot chat interface with the user actively typing a message. Once text is entered in the message bar, a green send button appears on the right. The user can tap this button to send their question or command to MEXBot and receive instant AI-generated responses. This enables smooth and interactive communication within the chat.

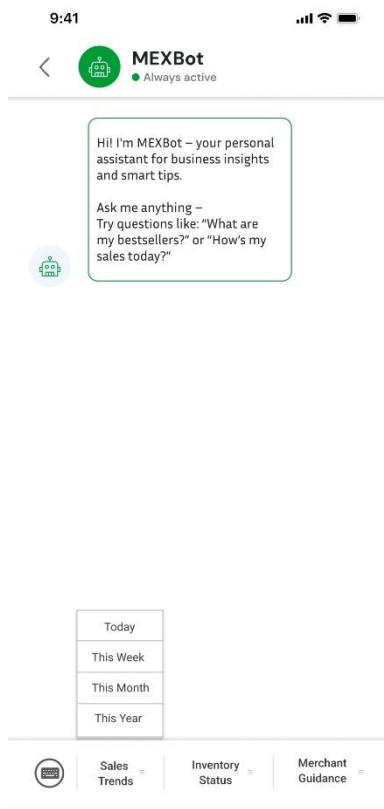


This screen shows the full chat interaction flow with MEXBot. The user typed a question, “What is the best sell today?”, and MEXBot instantly responded with, “Fried Chicken Bento – 42 orders so far!” The message is clearly displayed in a green bubble to indicate a successful AI response. This seamless exchange highlights how users can send messages via the green send button and receive real-time insights directly in the chat. All previous alerts remain visible, making it easy for users to scroll back and review important updates.

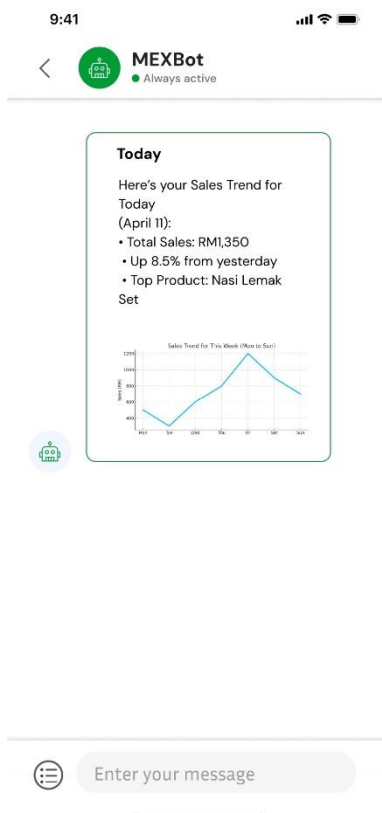
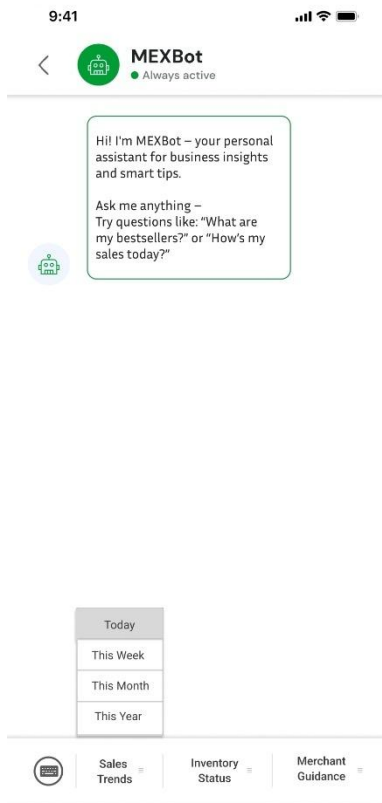


The interface lets users switch between two modes: tapping the menu icon reveals quick-access buttons for Sales Trends, Inventory Status, and Merchant Guidance, while tapping the keyboard icon brings up a message input bar for chatting directly with MEXBot. This seamless toggle allows users to easily access insights or ask questions in real time.



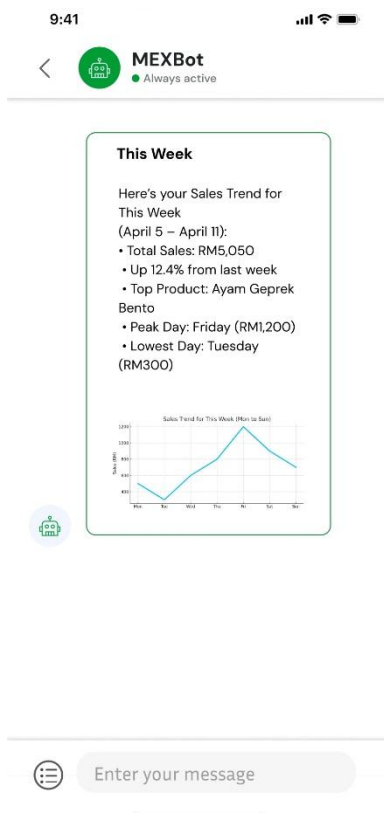
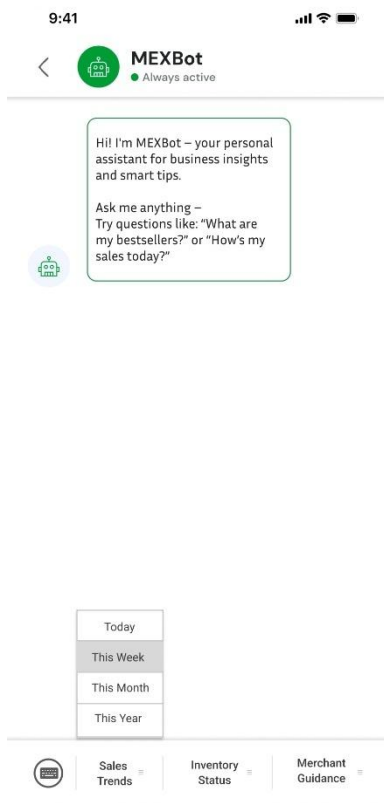


This screen shows the user tapping the Sales Trends button, which opens a dropdown menu with four time range options: Today, This Week, This Month, and This Year. This allows users to quickly filter and view sales insights based on their preferred time period, making it easy to track performance over different durations.



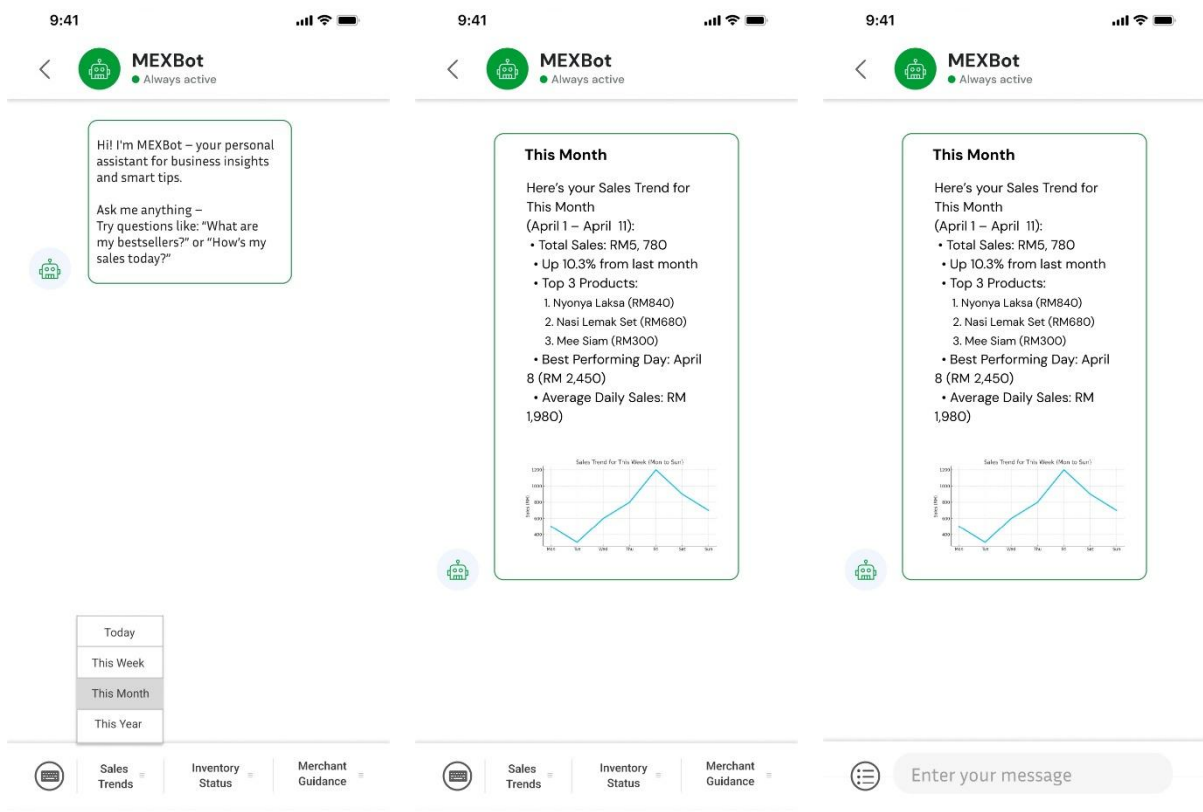
This sequence shows the user journey from selecting a sales trend to viewing the result. First, the user taps Sales Trends and selects Today from the dropdown. MEXBot then responds with

a detailed sales summary for the day, including total sales, percentage growth, and the top-selling product, and a line graph showing the sales pattern throughout the day. Users can switch back to the message input by tapping the keyboard icon at the bottom left to ask follow-up questions or explore other insights.



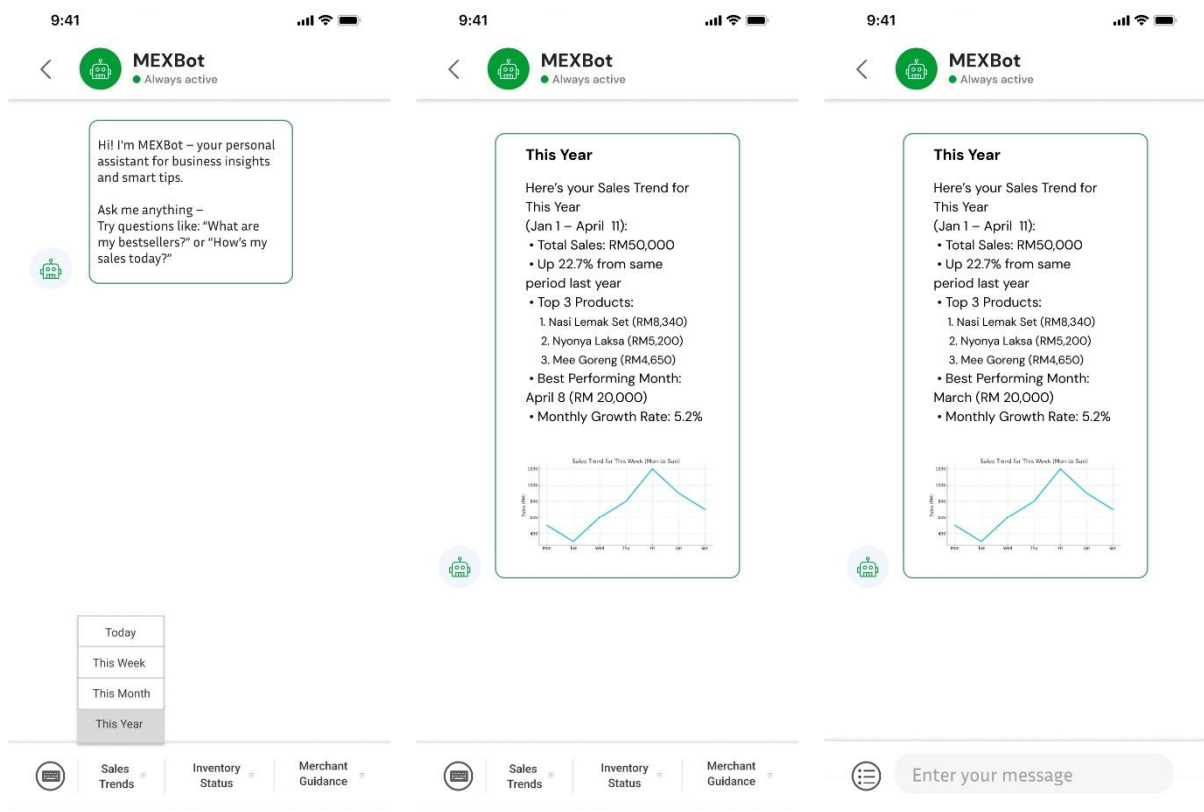
This sequence shows the flow when the user selects “This Week” from the Sales Trends dropdown. MEXBot responds with a weekly sales summary, including the total sales,

percentage growth, top-selling product, as well as the peak day and lowest day. A line graph visually presents the weekly sales trend. To return to the chat input, the user can tap the keyboard icon to bring up the message bar.



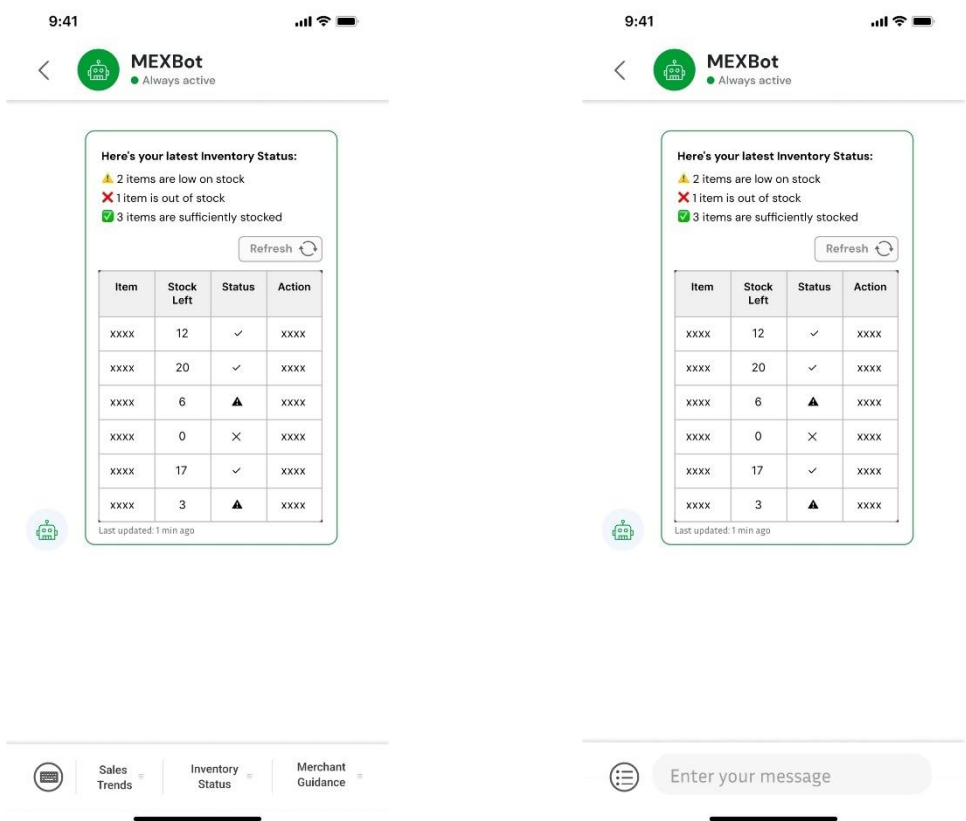
This sequence shows the user selecting “This Month” from the Sales Trends dropdown. MEXBot responds with a comprehensive monthly summary, including total sales, growth rate from the previous month, and the top 3 products of the month. It also highlights the best

performing day and the average daily sales. A line graph illustrates the sales trend throughout the month. The user can tap the keyboard icon to switch back to the message input for further interaction.



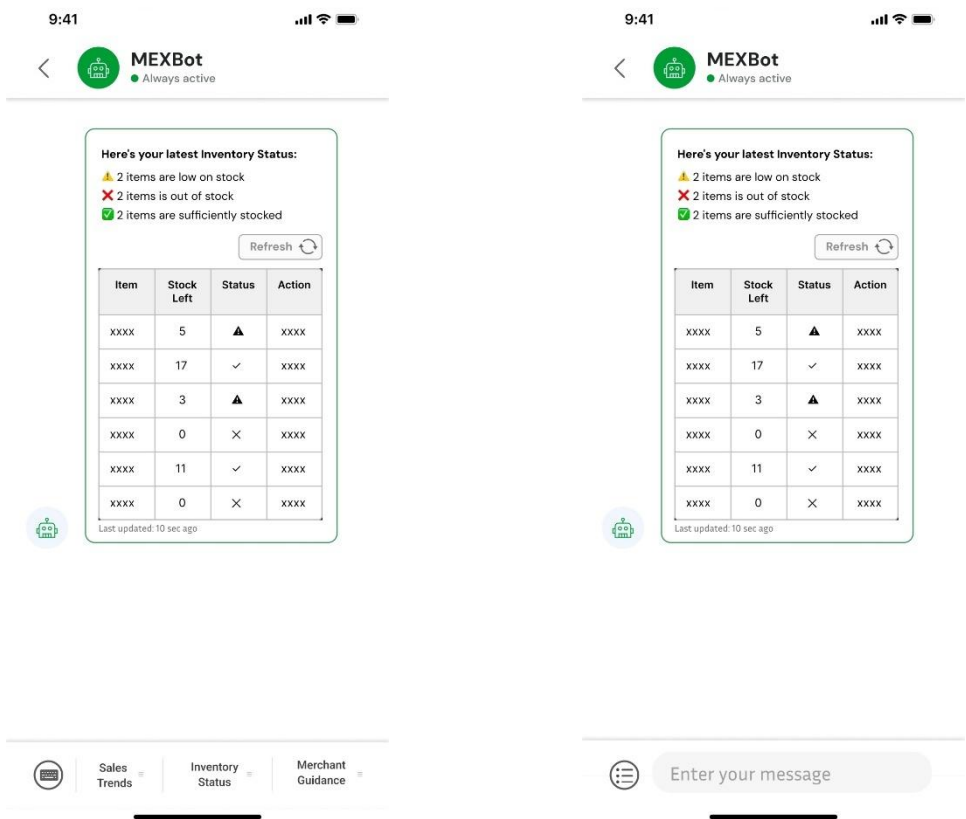
This sequence shows the user selecting “This Year” from the Sales Trends dropdown. MEXBot replies with an annual sales overview, displaying total sales, a growth rate from the same period last year, and the top 3 products of the year. It also highlights the best performing

month and the monthly growth rate, supported by a line chart illustrating sales progression. The user can tap the keyboard icon to return to message input for further interaction.



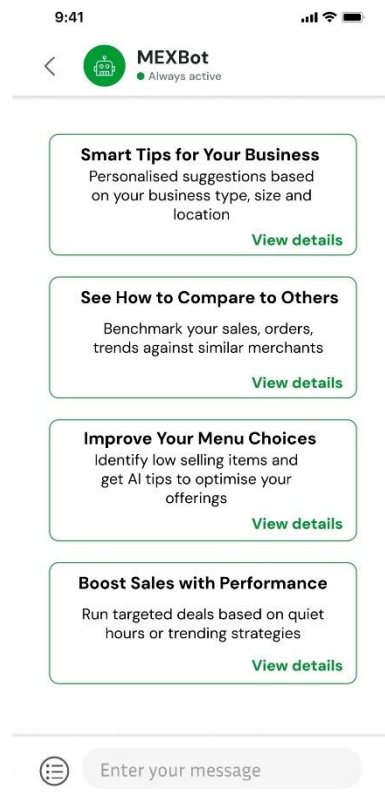
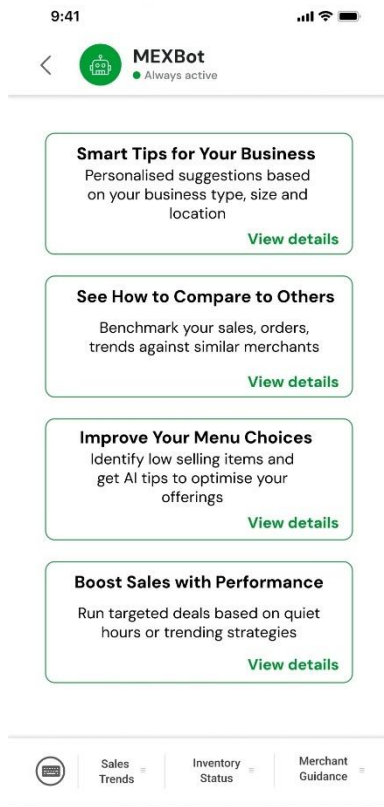
The Inventory Status provides users with a real-time overview of their stock levels, assisting them quickly identify which items need restocking. Each item is listed with its current stock quantity and a corresponding status icon—checkmarks for sufficiently stocked items,

warnings for low stock, and crosses for out-of-stock items. A summary at the top of the page displays the total count of items in each status category for quick assessment.

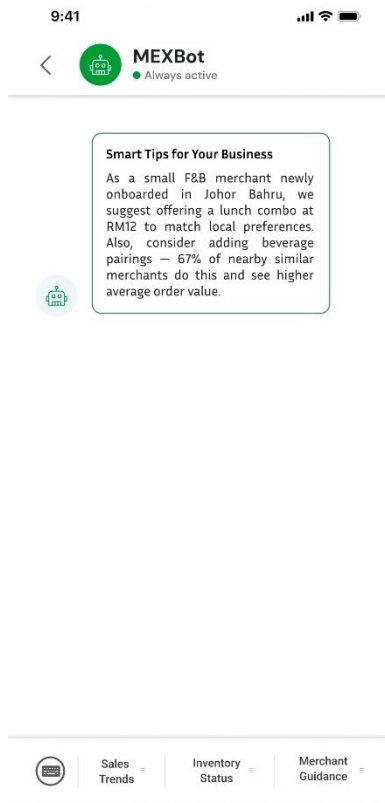


To ensure accuracy, users can tap the Refresh button, which instantly updates the inventory data and refreshes the summary based on the latest stock information. A timestamp below the inventory table shows when the data was last updated, giving users confidence in its freshness. Therefore, this supports proactive inventory management and ensures users can respond to stock changes in a timely manner.

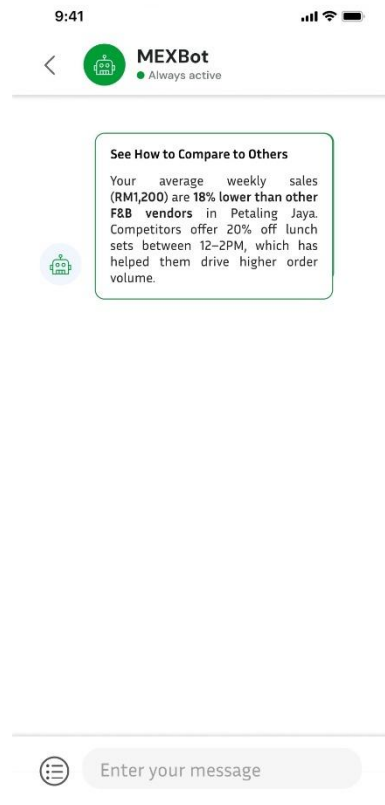
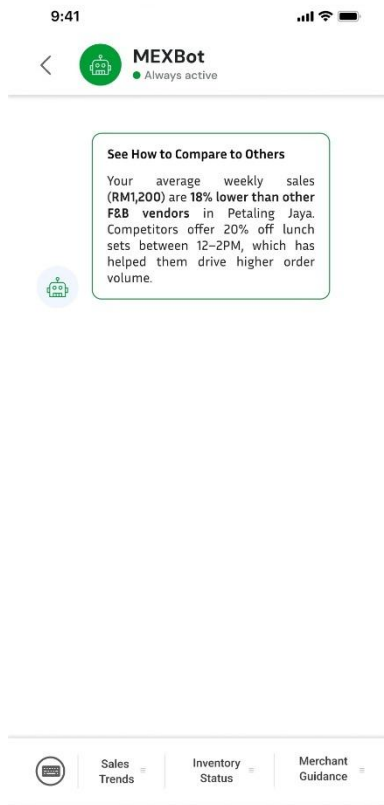




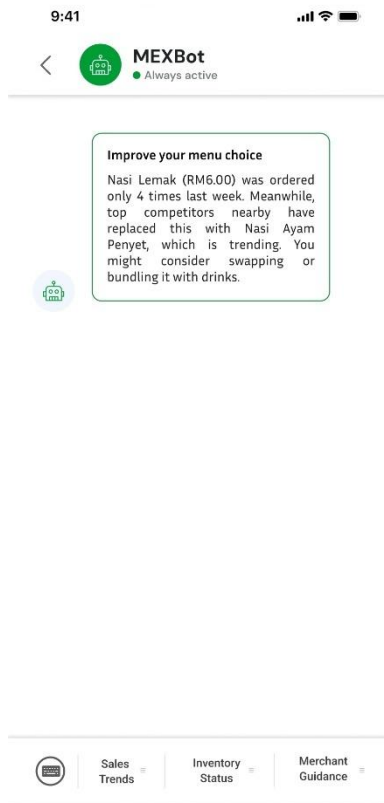
This screen displays four categorized business advice, allowing merchants to explore tips across different areas, which are Sales Optimization, Customer Retention, Inventory Management, and Promotions. Each category is represented with a card-style layout, which users can tap “View details” to continue for related recommendations. This structure enables merchants to focus on specific aspects of their business and receive tailored guidance aligned with their current goals or challenges.



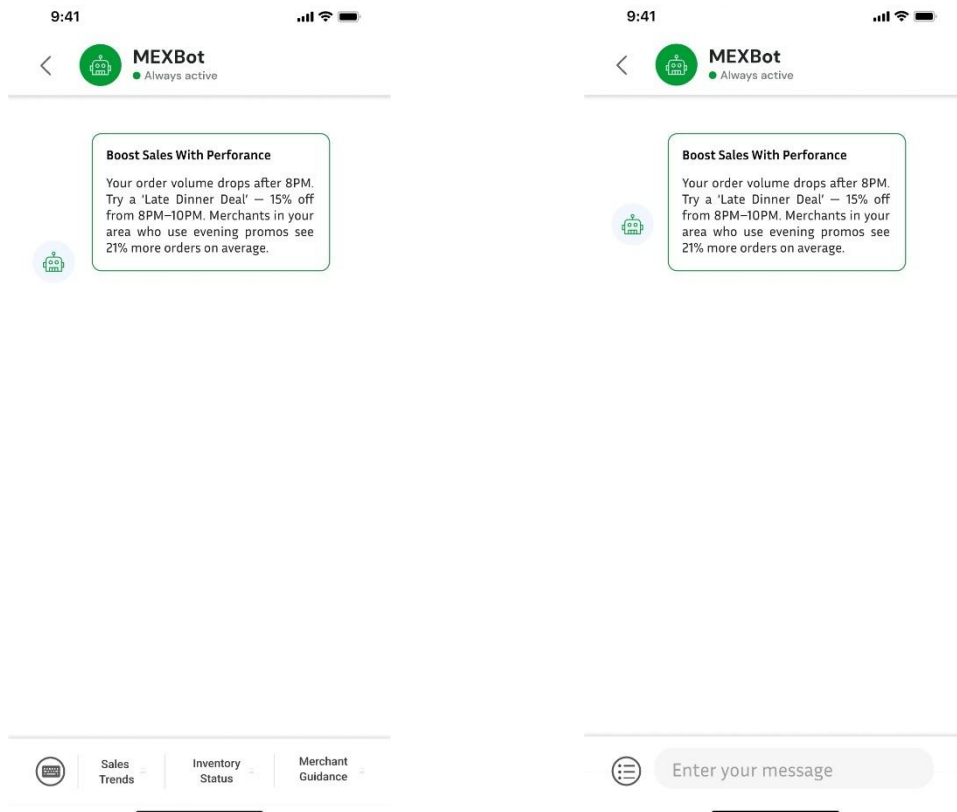
This screen appears after the user selects “View details” under Smart Tips for Your Business in the Merchant Guidance section. MEXBot displays a personalized recommendation that includes tailored advice based on the merchant’s type, scale, location, and business maturity. Users can return to the chat input by tapping the keyboard icon at the bottom.



This screen appears after the user selects “View details” under See How to Compare to Others in the Merchant Guidance section. MEXBot provides a performance comparison against similar merchants nearby, helping users understand how they rank in areas like sales and promotions. This allows merchants to identify gaps and opportunities for improvement based on local market benchmarks.



This screen appears after the user selects “View details” under Improve Your Menu Choices in the Merchant Guidance section. MEXBot provides item-level suggestions by identifying underperforming products and recommending actions—such as swapping with trending items or bundling with drinks—to enhance menu relevance and boost sales performance.



This screen appears after the user selects “View details” under Boost Sales with Performance in the Merchant Guidance section. MEXBot provides promo suggestions tailored to address low-performing hours, such as times when sales typically drop. It recommends targeted strategies—like time-based discounts—based on local merchant behavior and data trends to help increase order volume during slow periods.

- Error handling and fallback mechanisms
  - If query is unmatched: suggest related keywords (from keywords.csv)
  - If data missing: fallback to nearest time window (e.g., use “This Week” if “Today” empty)

## **2. Data Utilization**

### **Data Sources**

- Types of merchant data being utilized
  1. **Transactional Data**
    - Sales records (time, amount, items)
    - Payment methods
    - Discounts/promotions applied
    - Customer count per transaction
  2. **Inventory Data**
    - Stock levels
    - Product movement rates
    - Supplier lead times
    - Waste/spoilage records
  3. **Operational Data**
    - Opening hours compliance
    - Order fulfillment times
    - Staff scheduling
    - Equipment uptime/downtime
  4. **Customer Data**
    - Repeat customer ratios
    - Average order values
    - Rating/feedback trends
    - Demographic patterns

### **External Data Sources:**

- **Market Trends:** Grab's aggregated platform data (category benchmarks)
- **Competitor Intelligence:** Web-scraped menu/pricing data (ethical collection)
- **Economic Indicators:** Government-published inflation rates, GDP growth
- **Weather Data:** Local weather API integration for demand forecasting

- **Event Calendars:** Public holidays, local festivals, school schedules
- How data is collected and aggregated
  - **Internal Systems** (Grab's existing platforms):
    - **Transactional Data:** Sales, orders, and inventory levels via merchant APIs.
    - **Operational Data:** Staff logs, fulfillment times, and customer feedback from Grab's backend databases.
  - **External Sources:**
    - **Market Trends:** Aggregated benchmarks (e.g., "average sales for bubble tea shops in Manila") via Grab's analytics or third-party APIs.
    - **Contextual Data:** Weather, local events, or economic indicators (e.g., inflation rates) from public APIs.
  - Data is processed in three stages:
    - **Normalization:** Standardizing formats (e.g., converting currencies, time zones).
    - **Enrichment:** Augmenting raw data with external context (e.g., labeling sales spikes with weather conditions).
    - **Time-Windowing:** Rolling averages (7-/30-day) for trend analysis.
- Data refresh rates and synchronization methods
  - **Refresh Rates:**
    - Real-time ( $\leq 1$  min): Transactional data, inventory alerts
    - Hourly: Sales aggregates, stock predictions
    - Daily: Market benchmarks, competitor pricing
    - Weekly: Macro trends

## Data Processing

- Methods for extracting insights from raw data

We employ ETL (Extract, Transform, Load) pipelines to process merchant data, using data wrangling techniques to clean and normalize transactional records. Through

feature engineering, we create meaningful derived metrics like sales velocity and inventory turnover ratios. Dimensionality reduction (PCA) helps simplify complex datasets while preserving key patterns, enabling more efficient analysis of business performance.

- Analytics algorithms and statistical methods used

Our system leverages supervised machine learning models like Random Forests for classification tasks (e.g., predicting high-risk stockouts) and ARIMA time series models for demand forecasting. We implement clustering algorithms (k-means) to segment merchants by behavior patterns, and apply natural language processing (NLP) to extract themes from customer feedback. Bayesian inference helps quantify uncertainty in our predictions, providing confidence intervals for recommendations.

- Real-time processing techniques

For instant insights, our system analyzes data the moment it comes in. When a merchant gets a new order, we immediately check if it's unusually large (suggesting a bulk buyer) or if stock is running low (triggering a restock alert). Fast-moving data—like live sales or weather changes—flows through streamlined pipelines that update dashboards within seconds. This lets merchants react quickly, like adding staff during a sudden lunch rush or pausing discounts when stocks are low. Real-time tools ensure advice is always based on the latest information, not yesterday's data.

- Historical data analysis approach

For long-term strategy, we examine months or years of past performance. We group old sales by season, compare yearly growth, and identify recurring events (like holiday booms). This reveals big-picture insights—for example, “December sales always double, so hire temp workers early” or “Your coffee sales plateau every summer—try cold brew promotions.” Historical trends help merchants plan ahead, while real-time data handles daily decisions. Together, they provide both instant alerts and strategic guidance.



## **Data Visualization**

- Visualization techniques for different types of insights

Visual representations on the Sales Trend page explain detailed data, including total sales, best-selling items, and daily sales variations, in simple way for users to understand.

- Chart and graph selection rationale

Line charts are selected as it is perfect for displaying trends over time. From a single day to the next, users can effortlessly track the activity and spot trends like mid-week drops or busy weekends. The strategic use of colours such as red for decrease and blue for expansion adds visual clues that help direct interpretation.

- Data simplification strategies for clarity

Data simplification ensures that complex business information is presented clearly and understandably. It translates data into simple, conversational summaries and prioritizes only the most relevant metrics based on context. Several strategies are conducted to help merchants quickly grasp insights without being overwhelmed. By tailoring communication to local languages and business maturity levels, the assistant becomes an effective, easy-to-use guide for decision-making.

## **Data Privacy & Security**

- Data anonymization techniques

We protect merchant privacy by carefully modifying sensitive data before analysis. For reports comparing business performance, we group merchants into categories (like “cafés in Manila with 10-15 staff”) so no single business can be identified - a technique called k-anonymity. Exact sales numbers are rounded to ranges (e.g., “₱50,000-₱55,000” instead of “₱52,379”), and we add small, random variations to the data that preserve overall trends without revealing specifics (differential privacy). When sharing success stories, we combine data from multiple similar businesses to create composite examples that don't expose any single merchant's information. These methods ensure insights remain useful while protecting individual identities.

- Compliance with regional data protection laws

We protect Malaysian merchant data using GDPR-inspired anonymization methods tailored to local needs. For business benchmarking reports, we implement k-anonymity by grouping merchants into clusters of at least 10 similar businesses (e.g., “PJ mamak stalls with RM8k-12k monthly sales”). Sensitive figures undergo controlled rounding (to nearest RM500) and noise injection that preserves accuracy within 5% while preventing identification. Location data is generalized to sub-district level rather than exact GPS coordinates. Our system automatically screens outputs to prevent re-identification through combined data points - a process vetted by Malaysia's PDPA consultants.

- Access control and permission models

We use a tiered security system where employees and systems only see the data they absolutely need. Store managers can view their location's performance but not neighboring stores. Regional analysts see aggregated patterns but not individual merchant details unless specifically authorized. Every data access is logged and monitored, with alerts for unusual activity (like after-hours access attempts). Multi-factor authentication is required for sensitive operations, and API access tokens automatically expire after short periods. Merchants themselves control what's shared through a simple dashboard - they can choose to hide specific metrics from reports or revoke third-party app permissions with one click. Regular penetration testing ensures these protections remain strong against emerging threats.

### **3. Personalization Strategies**

#### **Merchant Segmentation**

- How merchants are categorized (business type, size, location)

The food and beverage (F&B) industry is used to categorise the merchants since it enables the assistant to offer insights particular to the sector. For example, a F&B business may find it helpful to get advice on inventory control, sales patterns, and other business-improvement strategies.

Depending on variables like the number of transactions, merchants are usually categorised as micro, small, medium or large. This categorisation helps in customising the complexity of the insights offered to them. This enables the assistant

to make recommendations about local events, regional trends, and consumer behaviour unique to a certain area.

- Factors used for personalization

This assistant can recommend additional tips or techniques based on the information about the type, size and location of business. By keeping an eye on how merchants use platform features like loyalty programs and promotions, targeted deals are conducted so that it could improve their business.

This assistant provides engagement data that is essential for streamlining corporate processes. In order to provide context and identify opportunities for improvement, peer benchmarking compares a merchant's performance with other merchants in the same industry. Merchants can find ways to improve and profit from their competitive advantage by examining these similarities.

- Segmentation model design

The segmentation model groups merchants based on both static attributes like business type, size, and location. Another attribute is dynamic behaviors such as transaction trends. It uses a algorithms logic to create targeted merchant segments. Each segment receives customized insights and engagement strategies, ensuring that the assistant's guidance is relevant and timely. The model is adaptive, continuously updating as merchants grow or change, allowing the assistant to stay aligned with each business's evolving needs.

## **Adaptive Intelligence**

- Learning mechanisms from merchant interactions

Adaptive intelligence focuses on how the assistant continuously learns from merchant interactions, adapts its behavior, and personalizes its recommendations based on business context, usage patterns, and feedback. Every interaction a merchant has with the assistant regardless of request for data, a question about performance, or a reaction to a suggestion that is used to refine the assistant's understanding of that specific user.

- Personalization algorithms

Several algorithms are used to analyse this data to recommend actions that are not only contextually relevant but also aligned with the merchant's past behavior and goals. For instance, if a particular merchant tends to act on pricing advice but ignores inventory suggestions, the assistant will prioritize pricing insights more frequently and in more actionable formats.

- How insights are prioritized for different merchant types

The assistant automatically adjusts the level of detail, data visualization complexity, and actionability of recommendations based on the merchant's business performance. This prioritization is further refined over time through reinforcement learning, where the assistant tracks how useful its past suggestions were and adjusts accordingly.

## **Contextual Awareness**

- How the system adapts to merchant context (time of day, business cycle)

The assistant excels at providing context-aware insights and guidance to merchant-partners. It shares its responses based on the merchant's specific business context, rather than offering generic answers. This contextual awareness involves recognizing temporal patterns, such as the time of day or stage in the business cycle. During peak hours, the assistant offers quick access to performance dashboards or real-time sales alerts. Outside of business hours, it highlights strategic recommendations like restocking advice or marketing tips.

- Location-based personalization factors

Location-based personalization is an important aspect of the MEX Assistant's functionality. Merchants operate in diverse markets with varying cultural, economic, and regulatory environments. The assistant adjusts its responses based on regional data, offering localized promotions, competitor benchmarks, and language support tailored to each area. For instance, merchants might receive alerts about operational bottlenecks and low inventory. Similarly, a retail store could be notified about positive trends that may impact shopping behavior.