

IoT Foot Traffic Monitoring Case Study

By

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Introduction

Client A is a retail company based on electronic gadgets. The client would like to leverage the latest innovation and development in the field of Internet of Things (IoT), in association with Maxis to better understand foot traffic of shoppers in their stores all across Malaysia.

Foot traffic

Foot traffic refers to the number of customers that walk-in or patron a store location. Monitoring foot traffic and customer activities while they are in a store can help business make better business and financial decisions, manage resources better, plan for future product promotions, understand customer behaviour and preference. just to name a few.

IoT devices can help clients monitor foot traffic in their stores and the data received from these devices could be utilised in helping clients manage their day-to day operations or even enhance their services and products.

IoT

IoT refers to the network of connecting and exchanging large volumes of data extracted from physical devices which are connected to the network, over the internet. These physical devices are embedded with sensors and software which captures real-time data and uploads the data streams into cloud or local databases and data warehouses.

The data harnessed can be processed into a meaningful format and together with machine learning capabilities, could be used as a powerful asset in assisting clients to make future predictions about their businesses, make recommendation systems, or even train AI applications.

Large volumes of data can be overwhelming for clients to understand; therefore, it is extremely important to process the data efficiently and gain significant insight from the processed data in order for our clients to benefit from the data retrieved.

Aspects to consider for IoT

There are several issues or aspects to consider when client chooses to incorporate IoT capabilities in their businesses. Client may lack the technical expertise and knowledge required in setting up, maintaining and managing IoT networks. Managing and operating infrastructure such as data warehouses and cloud systems may be very expensive and costly. There is also the issue of recruiting the necessary skilled professionals and employees with the relevant type of expertise to set up and handle the IoT networks and infrastructure. They may even need to provide training for their employees to understand the technology behind IoT systems and application.

Legal and compliance issues have to be taken into consideration when it comes to dealing with customer data and relevant data privacy regulations must be abided. Clients with no previous expertise with IoT rarely have existing synergies or infrastructure and system which could be leveraged to support IoT efforts. Another important aspect to consider is customer acceptance to the introduction of IoT elements in client's store premises. Network and data security is also a huge concern for business as hacking by irresponsible entities could severely disrupt business operations.

Maxis IoT solutions

Maxis can provide their expertise in the field of IoT and guide Client A in determining the best possible approach and the most efficient IoT system framework, catered specifically to meet the client's business needs and goals. From configuring IoT devices, handling network and connectivity aspects of the IoT system, managing cloud solutions, databases and data analytics.

The insights obtained through IoT solutions can help stakeholders in making important decisions on the future of their company and businesses. A cost effective IoT and cloud solution would be recommended based on client requirements.

Problem statement

Client A sells smartphones, smart tablets, smartwatches and laptops. They have hundreds of stores all across Malaysia in several states, mostly located in major cities. Several store managers of some branches have observed that the number of walk-in customers has decreased steadily over the past 2 years in some locations as customers prefer to order through online mediums with direct door delivery option and also due to competition from other store outlets selling similar electronic products. Large percentage of Client A's business has moved online.

As the cost of running brick and mortar stores or physical stores may be expensive, client would like to understand foot traffic of their shoppers better so they can apply cost saving measures. Some of the main costs to consider are operational costs of running the branch which includes rent of store, utility costs such as electricity and internet connection, transportation costs of bringing in products

from warehouse to store location, costs of staff salary and other miscellaneous costs, depending on the needs of each store location.

With the help of Maxis and their expertise in IoT, Client A would like to identify the foot traffic of each store and reevaluate the performance of each store branch. The number of overall walk-in customers is an extremely important indicator in determining the performance of each individual stores.

Monitoring foot traffic can help them answer several major questions and help decide the future of the branches. Together with foot traffic information and other relevant data obtained from the IoT system output, a machine learning method called, K-Means clustering can be performed to cluster the stores based on similarities in their performance. Branch locations which fall under the underperforming category will be considered for closing.

The main objectives are;

1. To determine which branches, have low walk-in customers and to shut down locations with low foot traffic and also low revenue and sales.
2. To reevaluate the number of staffs actually needed in stores especially during peak season with high foot traffic. Branches with more foot traffic may need more staff.
3. To determine suitable timings or seasons to introduce relevant kinds of promotions, in order to bring in more customers and increase sales. Certain kinds of promotions are more suited for seasons with low foot traffic and can help increase foot traffic.

Based on the main objectives, the main problem statements can be summarised as such:

1. Which store branches have very low foot traffic, low sales and low revenue and should be closed?
2. What is the optimal number of staff required for each branch at a given timing?
3. Which seasons are suitable for different kinds of promotions, based on foot traffic of the particular sales season?

Proposal of solutions

First, it is important to identify what data we would need to collect in order to solve the problem statements, through what data source and which physical IoT devices will we be able to extract the data we need from, method of data extraction and data storage considerations, data pre-processing, machine learning model building development, model evaluation and finally data analytics.

The final findings from the data analytics process would be presented to stakeholders for their deliberation and to make final decisions regarding the store branches.

To give a better perspective of the location of each store branch, several other information is taken into account such as the state and city of the stores, whether the store is located in a shopping mall

or nearby a shopping mall, facilities in each store, number of staffs in each store, sales and revenue of each store, and promotions conducted in each store, just to name a few.

From monitoring foot traffic using various IoT devices, we can also get several information,

1. Number of customers at any given day and time or season (for example during national holidays, 7/7 sale etc).
2. Demographics of customers such as gender and age group of walk-in customers.
3. Customer preference (which products are in demand, which products are customers interested in reviewing and trying out, their interest in products displayed or even what other devices are they carrying with them such as type of handphone)
4. Customer spending habits (which products are usually purchased during specific seasons or promotion period)
5. Customers preferred mode of payment (cashless transaction such as online transaction, credit card, debit cards, cash or through instalment packages)

IoT devices

There are several IoT devices and methods which can be used to detect foot traffic such as:

1. Using video surveillance cameras together with face recognition AI software application in store locations

Cameras could be placed in strategic locations in stores to record and monitor the presence of customer in stores at any given time in a day, for example the time they enter and leave the store and how long they spend in the store.

Specially trained AI facial recognition software applications could be used to gauge the age and gender of customers to determine demographics of customers.

The application should also be able to sense if customers are visiting as a family unit, individually or in a group and count the number of people at a store at any given time excluding the staffs in the store.

The foot traffic or number of customers in store, together with revenue and sales records can help Client A understand the effectiveness of promotions.

However, there are several drawbacks when it comes to using face recognition application. Face recognition software may not be reliable enough to determine the gender of individuals that walk into the store. The application may not be able to accurately identify customers who are coming in groups of friends or families, therefore the information gathered might be inaccurate.

Furthermore, storing facial recognition data without the consent of store visitors could lead to legal and compliance issues.

2. Monitoring cashless payment methods

By monitoring payment transactions in particular cashless payment methods, Client A can get information on total revenue and sales of each branch, customers preferred method of spending and their product preferences based on products purchased.

However, foot traffic of individuals who do not make purchases will be missed out and not taken into account.

3. Scanning QR Codes

QR codes can be used as a way to track foot traffic in stores and to retrieve other relevant information in helping us solve the problem statements. Store staffs could encourage customers to scan specific QR codes when entering and leaving the store. This can help Client A to determine on average how long do customers spend in the store. Stores can also encourage the use of QR codes in promoting discount offers, special deals and rebates. Customers can get discounts by scanning on specific QR codes. This can help track customers' acceptance of promotions offered in stores.

Customers could also scan specific QR codes before trying out or testing any gadgets on display in stores. The QR code can help Client A to obtain information on customer preference and product acceptance.

However, customers may not mind scanning upon entry to the store, but they might not want to scan again while exiting.

4. Using motion sensor

Another method of tracking foot traffic is by using motion sensors. Motion sensors can be placed at entrance of the stores to keep track when people are entering and leaving the stores. The sensors get triggered when people move in or out through the entrance.

However, motion sensors will only be able to determine the amount of people walking in and out the store but it will not be able to determine the amount of time each patron spent at the store.

5. Using RFID tokens

Specific entry and exit sections should be created for the stores. Each visitor could be given a RFID token via a kiosk at the entrance and they will have to return the token when exiting the store.

The RFID tokens provides a unique identifier which will help in identifying each visitor individually while they are in the stores.

By scanning the token for entry and exiting, the client will be able to determine the exact amount of time each visitor has spent at the store.

Moreover, the store visitors will also be required to have their tokens scanned before testing each gadget on display in stores. By doing this, we can also determine which devices garner the most interest as well as the amount of time visitors spend on testing it.

The raw data required are extracted and obtained through the various IoT data sources and integrated together in a database system. The raw data then undergoes pre-processing stage where the data is filtered, formatted and standardised accordingly. To determine which data fields or inputs are necessary, feature scaling is applied.

K-means clustering (a machine learning method to partition data into several group based on their similarity) can be used to group data into several categories of performance (excellent performance, satisfactory performance, low performance) based on the feature criteria selected such as: foot traffic, revenue, sales, number of staff, just to name a few.

Store branches which fall under the low performance cluster would be recommended for closing.

Store branches which fall under clusters with high foot traffic would be recommended to increase their number of staff in those locations.

Pearson Correlation test could be used to determine the correlation between foot traffic and promotions.

Client A will be in a much better position to make a well-informed decision regarding the future of branches by taking into consideration the recommendations suggested based on the K-Means clustering results together with the relevant financial reports.