SOFTWARE REQUIREMENTS SPECIFICATION

Amazon Go

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Change History

Version	Date
1.0	03.03.2020
1.1	04.08.2020

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1   Introduction

This is a Software Requirements Specification for the system Amazon Go. The software and equipments mentioned in this document are the system itself and associated tools used for this system.

1.1   Purpose

Amazon Go is a system including stores automated by mobile applications. Amazon Go aims to reduce the time and effort spent by customers during their shopping. In order to do that, Amazon Go allows customers to purchase products without being checked out by a cashier or using a self-checkout station. Instead, customers show the QR code and use the Bluetooth technology when they both *enter* and *leave* the store. Between these two actions, they do shopping just as in regular stores.

1.2   Scope

- System will include an Amazon Go Mobile App which makes users able to enter to the Amazon Go stores, add products to their virtual cards or return the products back.

- System will have Amazon Go Stores, where customers could find the products that they want to buy, as in regular stores. What makes Amazon Go Stores different from the regular stores is the product-and-customer recognition system of the Amazon Go Stores. By using the hardware interface, such as shelves with weight-sensors and cameras, the stores are able to detect the product and the customer.

- System will contain IT Staff where the staff members will help the process in the store. The staff members will contribute to the system decision mechanism when there exists a suspicious situation for the black-box decision mechanism to decide.

- System will include transaction area, where customer needs to use whenever (s)he enters or leaves the store. This area triggers cameras to watch the new-coming customers, allow customers to leave the store and notifies the Mobile App for payment of the customer via Amazon Account.

- System will have Amazon Account, which is trivial for payment. When a customer is done with shopping in the Amazon Go store and leaves the store, the payment procedure is done via Amazon Account of the customer.

- System will have an enormous database, which lies at the heart of the system. The database keeps all the information about marketing and customers, coming from other parts of the system and will be used for marketing, advertisement and supplying needed products to store.

1.3   Product Overview

Amazon Go serves the products mobile app and stores which are elements of the Amazon Go system and offers a new way of user-friendly shopping by providing an automated cashier-free payment system

1.3.1   Product Perspective

Amazon Go is a system that provides customers the opportunity to shop without waiting in a queue in order to pay. General structure of the system involves a mobile app and an Amazon account as user interfaces. It uses a big database system as a system interface and a memory, which keeps track of products, customers, customers' interests etc. in order to inform retailers about products needed in stores, advertising and so on. Its database is being fed by the transaction-payment area, mobile app, Amazon account and technology used in store. The hardware interfaces of Amazon Go are sensors, cameras, turnstiles and shelves with weight-sensors. These interfaces may require maintenance and support when necessary. The main software that is used by Amazon Go is Amazon Go Mobile App. This app is crucial for Amazon Go system. It is one of the main decision mechanisms for allowing customer-candidates to enter the store. Those who want to shop in an Amazon Go store must have the Amazon Go mobile app. Amazon Go needs a powerful communication interface to function. The black-box technology behind Amazon Go needs data to run. The

data provided by hardware devices, must be transferred to the great mind of Amazon Go system. Wireless systems as Bluetooth and internet may not meet the standards for a fast-operating machine, therefore a well designed communication system with right hardware choices is a must have.
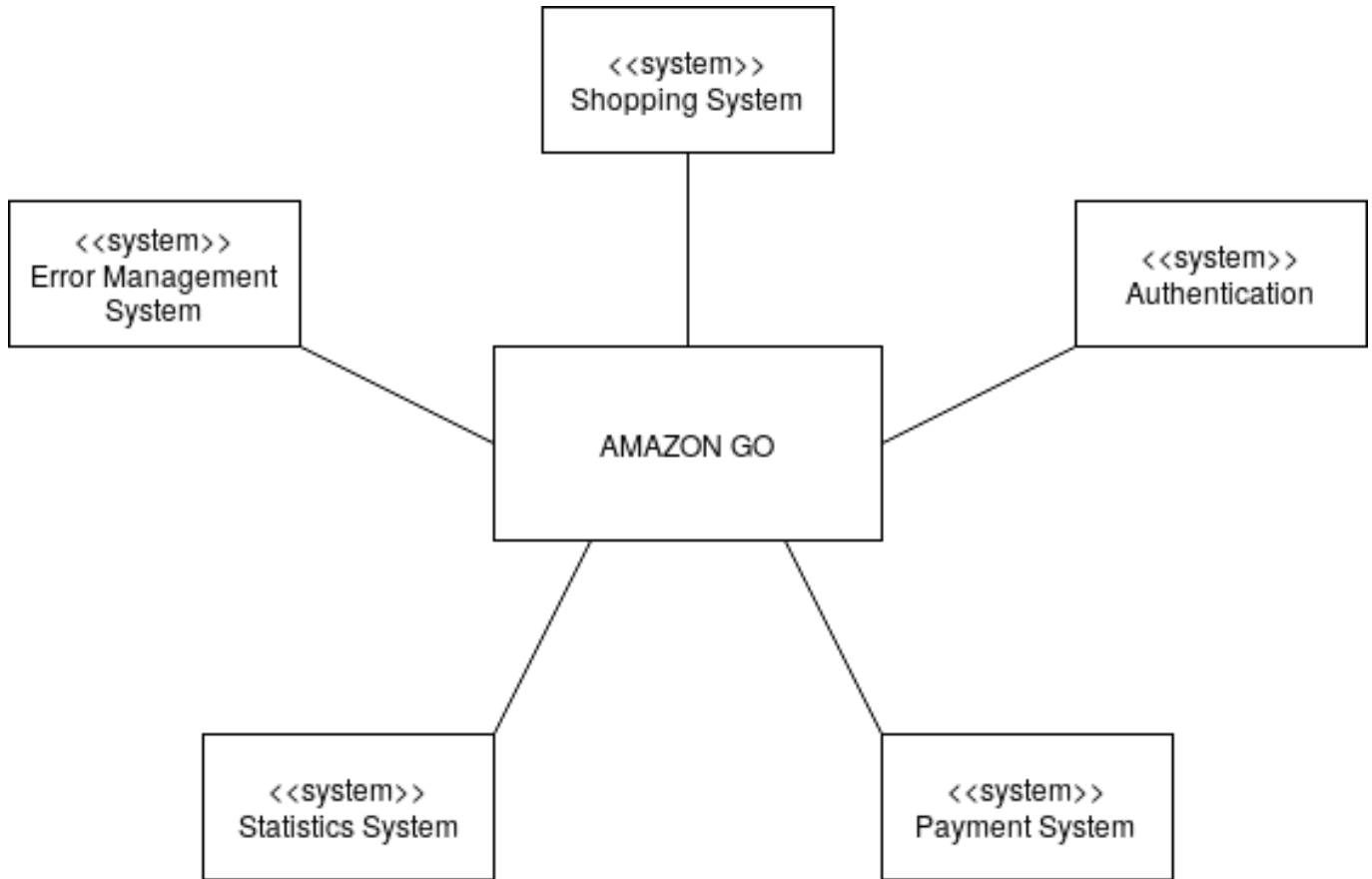
Figure 1: Context Diagram of Amazon Go

1.3.1.1   System Interfaces   Amazon Go requires some external and internal interfaces.

Error Management Interface: In Amazon Go system errors occur when the hardware has issues or the algorithms keep the system working, run into bugs or there are unusual behaviour has not been detected by the system before. These errors sometimes should be easily fixable. The error management system detects the erroneous part and also suggest some solutions.

Database Management Interface: All the data retrieved by various Amazon Go elements(hardware, app, retailers, staff) is gathered in the database. Database provides data for the production of statistics and it also feeds the Artificial Intelligence and Machine Learning.

Amazon API: Users must sign up to Amazon and must choose a payment method. Amazon API handles the sign up requests and decides if the payment method is valid or not.

1.3.1.2   User Interfaces   User interfaces of Amazon Go system can be examined under two headings namely customer and IT Staff. We can define end-users as the customers who use the mobile app and staff who reviews and checks the errors and the operation of the system.

Amazon Go Mobile App User Interface: Amazon Go Mobile App is one of the main things that keep Amazon Go running. Everyone who wants to shop at an Amazon Go Store must download the app. The app must be comprehensible and easy to use for customers from different age groups, education levels and backgrounds. Below are some screenshots of the Amazon Go Mobile App.
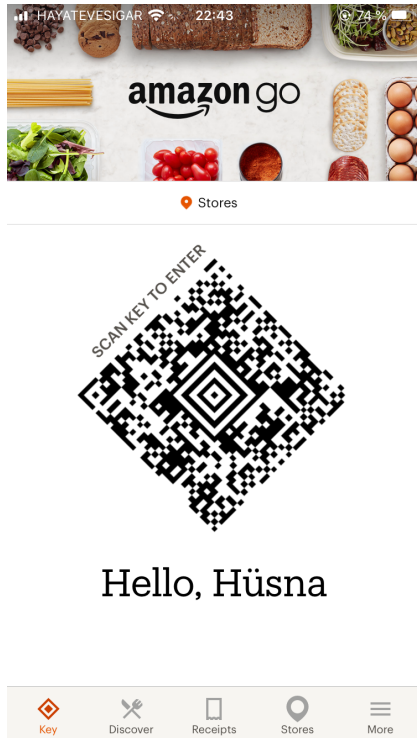
Figure 2: Amazon Go QR Code
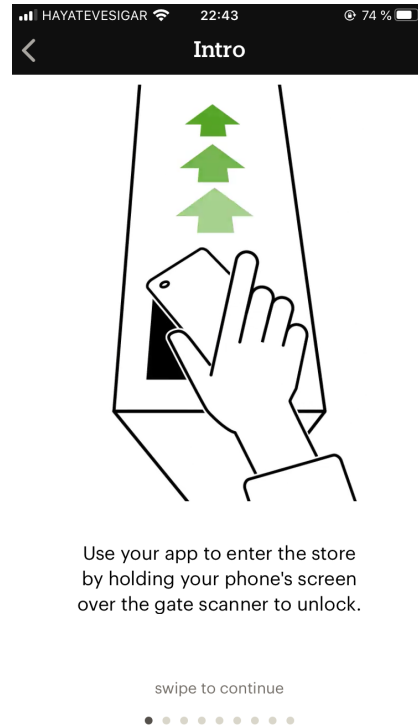
Figure 3: Amazon Go Entrance

You can also use your app
to let your friends and family in.
Simply scan to let them in first.
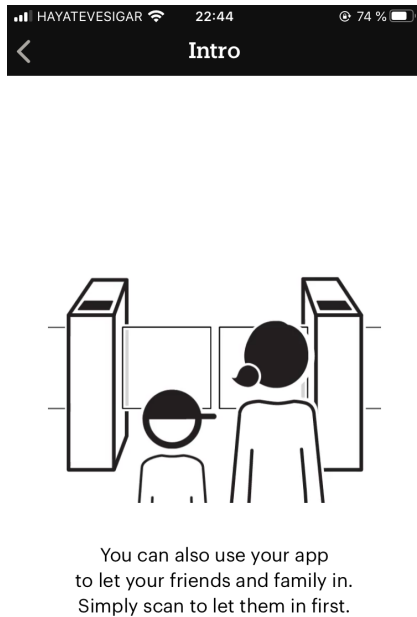
Figure 4: Amazon Go Entrance with Companions

Anything you take
off the shelf is automatically
added to your virtual cart.

Figure 5: Amazon Go Taking-off an Item

Anything you put back
on the shelf comes out
of your virtual cart.

Figure 6: Amazon Go Put Item Back

It works the same for items
taken (or put back) by
friends and family you scan in.
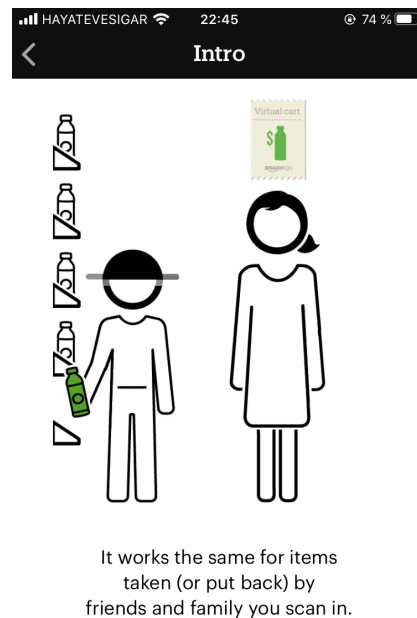
Figure 7: Amazon Go Companions' Shopping
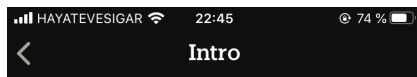
Figure 8: Amazon Go Taking for Others
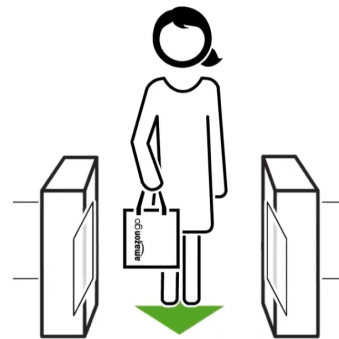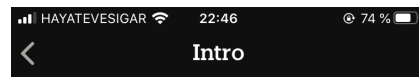
Figure 9: Amazon Go Exit
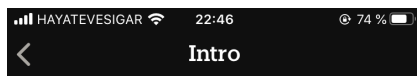
Figure 10: Amazon Go Receipt
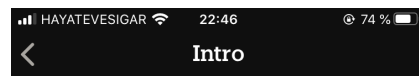
Figure 11: Amazon Go Start Shopping
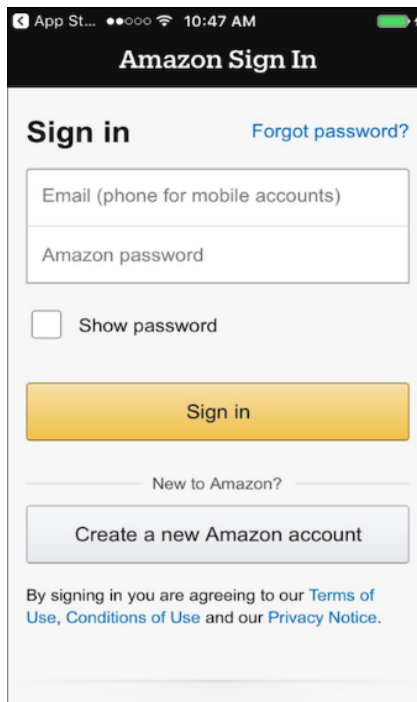
Figure 12: Amazon Go Sign In
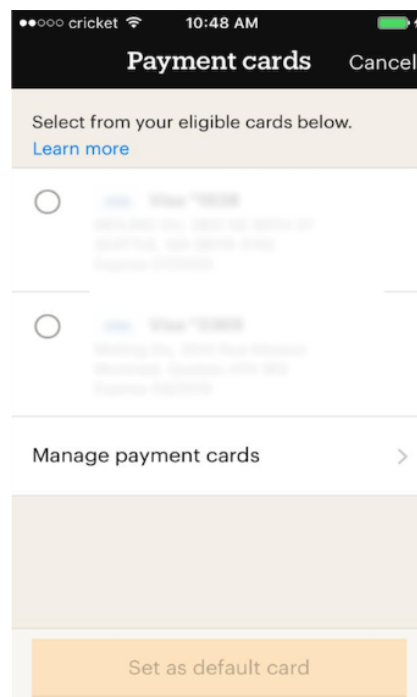
Figure 13: Amazon Go Payment Cards
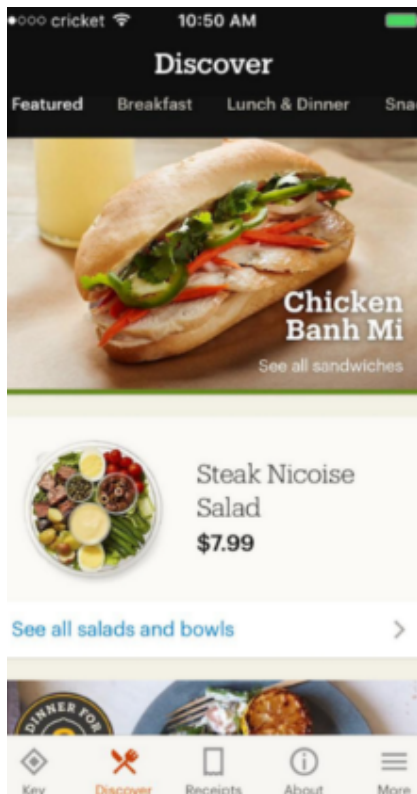
Figure 14: Amazon Go Discover
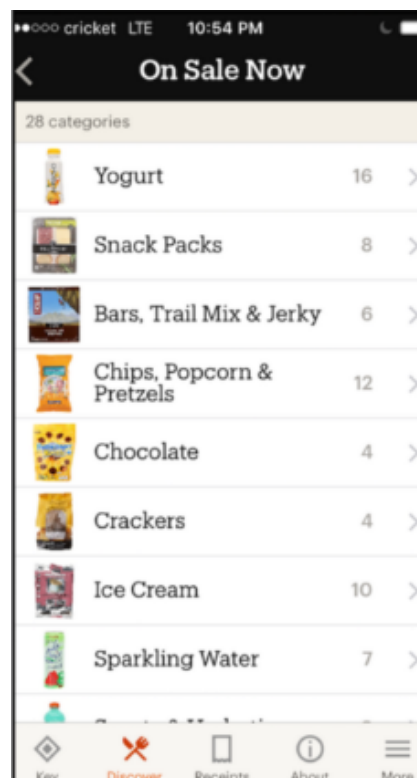
Figure 15: Amazon Go Products on Sale
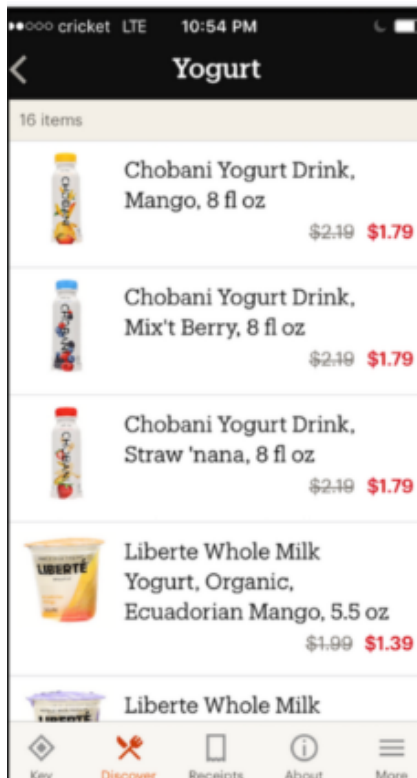
Figure 16: Amazon Go Discover Yoghurts

Figure 17: Amazon Go Yoghurt Detail
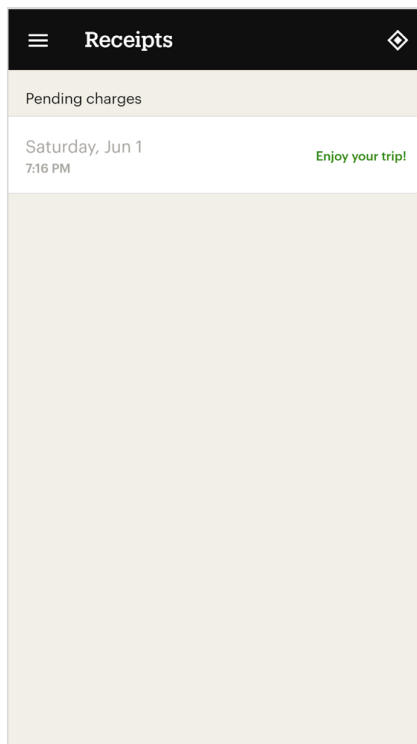
Figure 18: Amazon Go Receipt History
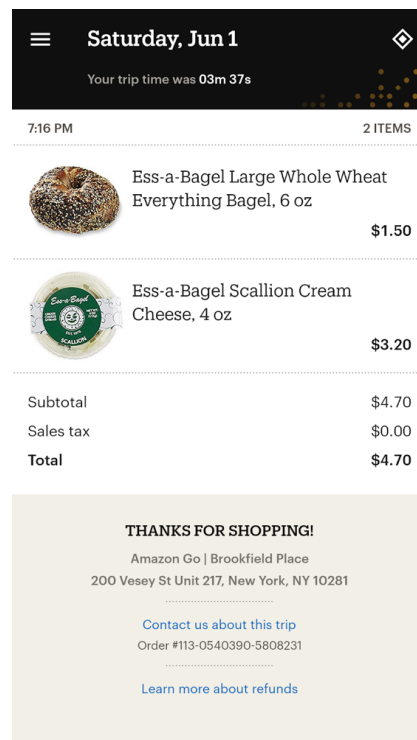
Figure 19: Amazon Go Receipt View

IT Management System: IT Staff uses a management system, which shows the details of the process. IT Staff can interfere with the functioning when necessary. The management system does not have to be particularly easy to comprehend, since it will be used by highly skilled or trained employees.

1.3.1.3 Hardware Interfaces The hardware of the system includes cameras, sensors and Amazon Go QR code scanner on the transaction area. There are cameras on ceiling recording the store from different angles, used for identifying customers. Shelves include weight sensors identifying the product taken from a specific shelf by the differentiation of that shelf. QR scanner, on the other hand, scans the QR code and opens the gate if the code is valid. Cameras are connected to the computers of system with wires above ceiling, which sends records simultaneously in order to let the computers process the images. Weight sensors, on the other hand, are hidden in the shelves and they act like the interrupt mechanism of today's computers. When a change on the shelf's weight occurs, sensors send the data of difference weight of that shelf to the computers by wireless connection and black-box technology of these computers identify the product by its weight and information of the products on that specific shelf. Every shelf has its own sensor.

There also exists an Amazon Go QR scanner on the transaction gate, working as regular QR scanners but scans only the special code produced for Amazon Go. This scanner scans the code and evaluates whether the code is valid or not with an embedded system. Then, according to the result of this evaluation, the gate is either opened or not, which is just like a basic gate switch.

Here are some images from an Amazon Go store, showing gate scanners and cameras, respectively.

Figure 20: Transaction Gate of an Amazon Go Store

Figure 21: Cameras in an Amazon Go Store

1.3.1.4 Software Interfaces   The software interfaces used by Amazon Go are DBMS, operating system and programming languages.

   DBMS: Amazon Go uses a database to keep the information about customers, their shopping preferences, shopping histories, best-seller products and brands, time spent in a store by each customer, products that customers are interested in but do not buy and camera recordings.

   Operating system: There is no constraint for the operating system of Amazon Go. Nevertheless, Linux and/or MacOS distributions could be preferably used due to security issues. On the other hand, both Android and iOS are needed to be tested the mobile app.

   Programming Languages: As mentioned, the Amazon Go Mobile App should either be written in both Swift and Kotlin-like language for Android, or Dart with Flutter framework.

1.3.1.5 Communication Interfaces   Amazon Go requires internet connection, obviously. Also the hardware needs to communicate with each other. The database is updated with the information retrieved from the store hardware. All this information exchange requires powerful communication interfaces. This communication can be established with cables or wireless systems.

1.3.1.6 Memory Constraints   Since the system engineering is handled as a whole, there are no memory constraints for Amazon Go system.

1.3.1.7 Operations   The operations of Amazon Go can be listed as the following:

- Authentication
- Making Decisions
- Payment
- Enter the store
- Exiting the store
- Produce Personal Ads
- Keep Statistics
- View System Logs and Report
- Keep Tracks of Customers in the Store
- Use Statistics
- Handle Errors
- Add Products to Virtual Cards

1.3.2 Product Functions

No	Functionality	Description
1	Make the decision of who bought the item	When a user grabs the item from the shelf, the system detects which customer it is, in order to add the item to the customer's virtual card.
2	Produce personal advertisements	Based on the information gathered from customers' accounts and actions, the system produces personal advertisements to increase sales.
3	Entrance	The act of customer's entering the store, beginning from the transaction area.
4	Exit	Customers' leaving the store.
5	Payment	As the customer leaves the store, account of that customer is charged and the customer is sent a receipt.
6	Keep track of customers in the store	Store hardware constantly calculates the location of the customers to make more accurate decisions.
7	Analyze which item is taken by customer	The system detects which customer has taken the item from the shelf
8	Add products to virtual cards	When a user grabs an item, the item is added to that user's virtual cart simultaneously.
9	Keep statistics	Information gathered from customers' shopping history and actions in the store are recorded and kept in database of the system.
10	Use statistics	The statistics kept in database can be used by IT Staff due to marketing and reinforcement purposes.
11	Handle errors	When an exception or erroneous situation happens, the IT Staff interferes and handles these problems.
12	View system logs	System logs, such as how many customers are in a store at an exact time, can be seen by the IT Staff members.

Table 1: Product Functions

1.3.3 User Characteristics

Users of Amazon Go system can be classed into three groups, which are named as IT Staff, customers and scientists, accordingly.

IT Staff: IT Staff members should be aware of how to use and understand the Amazon Go technology. In order to do that, they need to have basic computer skills. In addition, there need to be members who watch the cameras 24/7 in order to help the decision mechanism when it lacks.

Customers: The technology provided by Amazon Go is a new perspective for user-friendly shopping. Since it reduces the procedure for a regular shopping, anyone who is able to do shopping will not face with any physical difficulty. Though the product appeals to a wide range of customers, the customers without a credit card or debit account are not able to use Amazon Go. Thus it would be misleading to say, Amazon Go is achievable by all people independent from their level of income. A smart phone with Bluetooth connection is also required to enter an Amazon Go store.

Scientists: There should be data scientists working for the Amazon Go system in order to analyze the data kept and used in database. Moreover, there should be marketing experts who should do market research in order to involve in advertisement works of the system.

1.3.4 Limitations

Regulatory policies: Although Amazon Go keeps information of customers due to marketing and statistical purposes, that information should not be released with other companies. It should be encrypted and therefore should not be evaluated or used by hand but software (i.e. no interaction with anyone) instead.

Hardware limitations: Since Amazon Go stores detect both people and products with the major help of sensors and cameras, these equipment should be synchronized. Moreover, weight sensors should be sensitive enough in order to differentiate two products having similar weights. Cameras should also have high resolution in order not to get confused with customers. Customers' having smart phones with Bluetooth and Amazon Go App downloaded is also a must.

Interfaces to other applications: Amazon Go usage is limited with an Amazon Account in order to take payment of products from customers.

Parallel operation: Since the motto of the system relies on not waiting and therefore customers do regular operations fast and continuously, all the equipment of the system should work in parallel.

Audit and Control functions: IT Staff should audit when a return of a product happens or the blackbox technology is not able to make decision of the topics mentioned in other sections of this document. In addition, a control mechanism is needed to determine when the system should inform suppliers.

Higher-order language requirements: Since the Amazon Go Mobile App addresses both IOS and Android users, mobile developing languages such as Swift and Kotlin are needed. Moreover, since the system uses technologies such as computer vision, sensor fusion and deep learning, convenient frameworks for these technologies are also a must.

Signal handshake protocols: TCP will be used for database and communication between technologies of the system.

Quality requirements: Since the system is mainly based on shopping, advertising is a priority for the system and consistency lie in the heart of the system. Therefore, the system should always keep its database up-to-date. In order to do that, database should be backed up regularly. Reliability is also crucial. Stores should not lack of any product in order not to lose customers. In order to do that, recruiters should be informed periodically and products should never be out of stock.

Criticality of the application: System failure is not fatal, therefore it cannot be named as critical.

Safety and security considerations: Since Amazon Go trusts its customers and vice versa, there should not be any system deficit, such as not or incorrectly detecting a product. In addition, since customers provide so many information about themselves, database should be durable enough to resist for attacks.

Physical/mental considerations: Anyone having a smartphone with Amazon Go installed could easily use the system. Therefore, there is no physical or mental consideration for this system.

1.4 Definitons

Term	Definition
IT Staff	The people who deal with the problems when necessary and keep the system working.
Store	Refers to Amazon Go store with and all the including hardware unless otherwise stated.

Table 2: Definitions

2 References

This document is written with respect to IEEE 29148:2018 standard:

International Organization for Standardization (ISO). (2011). ISO/IEC/IEEE 29148: 2011–Systems and software engineering—Life cycle processes—Requirements engineering.

Other Sources:

Amazon.com: : Amazon Go. (n.d.). Retrieved April 3, 2020, from https://www.amazon.com/b?node= 16008589011

Coveley, M. (2004). U.S. Patent No. 6,725,206. Washington, DC: U.S. Patent and Trademark Office.

Martin, T., Wang, H., Artis, M. W. J. J. D., & Uncleback, A. Amazon Go! Cashierless Retail Analysis.

3 Spesific Requirements

3.1 External Interfaces
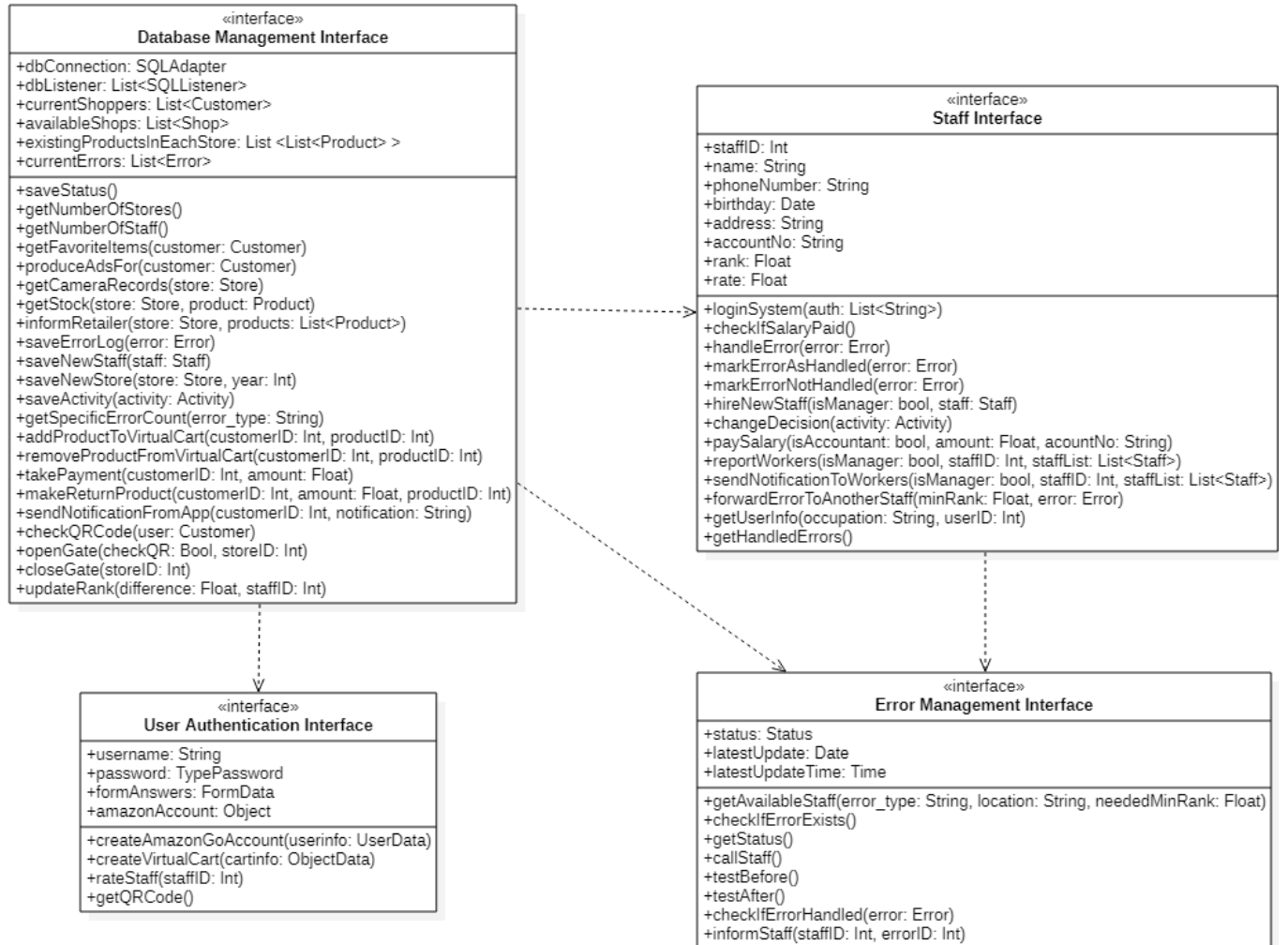
Figure 22: Amazon Go External Interfaces Class Diagram

- **User Authentication Interface**

  - Users should login to the interface with their Amazon account credentials. After that, they could fill the forms for some furthermore information about themselves.

  - They could rate the staff members whom took care of their problem(s), if any.

  - The QR Code produced by the mobile app should be scanned to the turnstiles at the entrance and exit for the authentication approval.

  - The gates in the stores are part of the authentication interface, they should work according to the result of the authentication system, i.e. if authentication is successful gate opens.

  - Payment method and the necessary information should be provided through the interface for the authentication.

- **Database Management Interface**

  - This interface should be handling and organizing all the data coming from different resources such as cameras and shelves.

  - It should be customizable so that IT Staff using the interface can work on it easily.

  - When a return happened, it is also kept in database and money and stock balance is also updated with respect to that return.

  - Database could gather the products that a customer is interested in, in order to make advertisements or suggestions based on these products.

  - New IT Staff and store information, errors, product stocks as well as the activities in the store should be saved with this interface.

  - This interface should be able to interfere in and provide information for user authentication system, by checking QR Code, and gate status.

  - Though the interface will be dealing with so many data, the interface's response time should be relatively fast.

  - The data gathered from other Amazon Stores around USA, should also gathered in the database, and should be easily accessible through the interface.

- **Error Management Interface**

  - Errors should have details and should be commentable by the IT Staff through this interface.

  - In this interface solutions and errors should be archived and accessible any moment.

  - This interface should be connected to the IT Staff Interface and keep the details of available staff, as the errors should be handled by the IT Staff.

  - Through the interface, IT Staff should be able to test the system before and after solving the errors.

  - Errors should be categorized to ease the search of a specific error.

- **IT Staff Interface**

  - In this interface there should be a ranking system, for a smooth version of hierarchy between IT Staff which will accelerate solving of the occurring problems.

  - Interface should have a notification function that keeps IT Staff notified of the system flaws, errors, situations require human decision mechanisms.

  - IT Staff should be able to communicate with each other through this interface.

  - All IT Staff should have profiles in this interface, and the comments or solutions they have contributed should be displayed in these profiles.

  - This interface should be a platform where IT Staff can collaborate.

  - Staff members are able to see the status of their salary.

  - If the appointed staff member is not able to handle the error, then (s)he could forward it to another appropriate staff.

  - If a staff member handles an error or forwards it to another staff, then (s)he updates the error status. Based on that update, database automatically changes that staff's ranking with respect to difficulty of the assigned error.

  - If the hardware decision system of the store makes an unfair decision, or could not decide at all, the staff member is able to intervene the decision by changing the activity record.

  - Based on their occupations, staff members are able to do different tasks, such as paying other members' salary, or hiring a new staff.

3.2 Functions
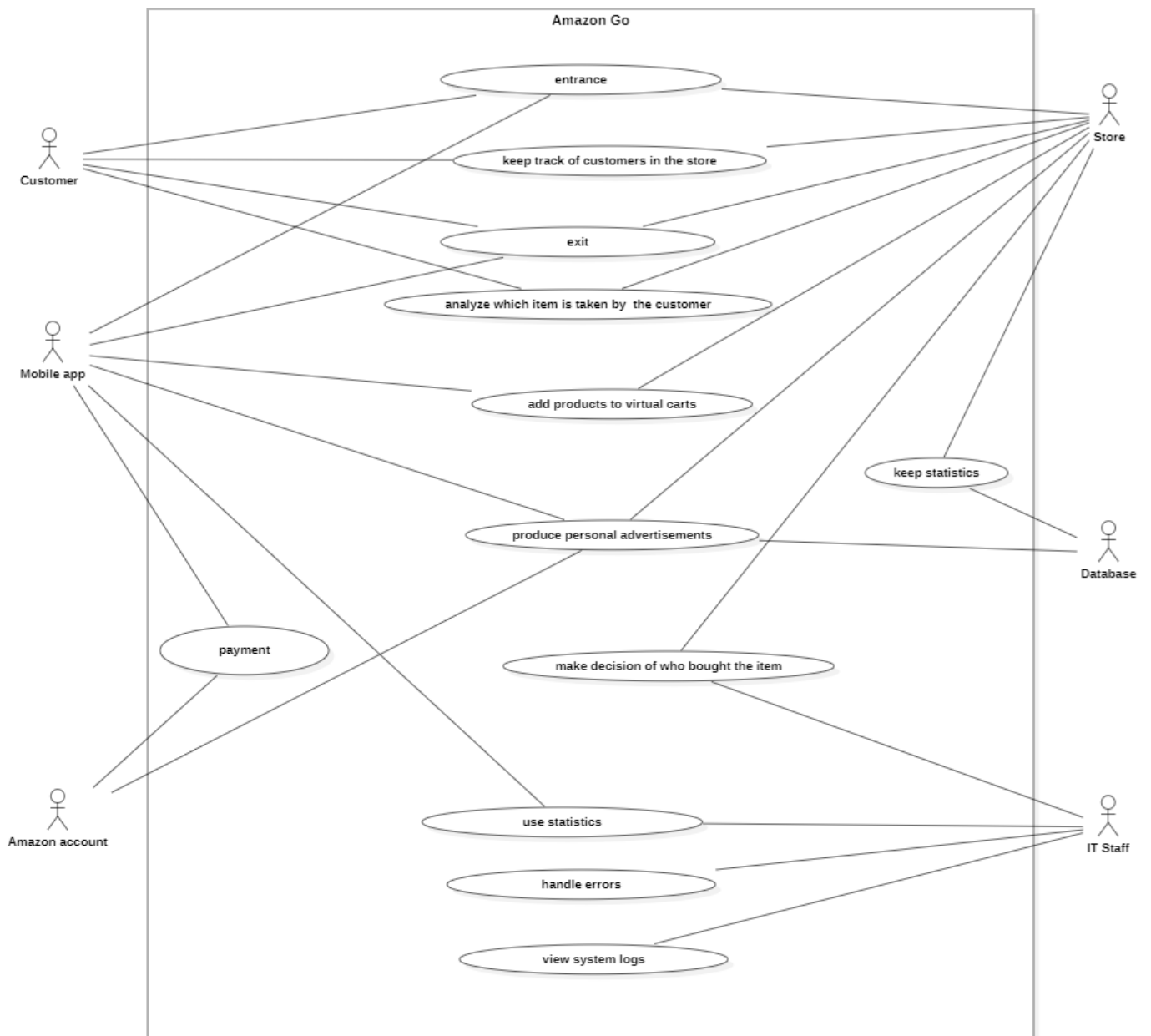
Figure 23: Use Case Diagram

Use Case Name	Make decision of who bought the item
Actors	IT Staff, Store
Description	When a user grabs an item from the shelf, this item is instantaneously added to the customer's virtual cart.
Data	Camera recordings, camera-based tracking system, IT Staff's observations
Preconditions	Customers and their companions (if any) must scan the QR code from Amazon Go mobile app when they enter the store. Moreover, there should be at least one staff member as back-up.
Stimulus	When an item is picked up, the black-box technology awakes the load and weight sensors on shelves and cameras recording the right angle..
Basic Flow so	Step 1 - Cameras start keeping track of new customers. Step 2 - When an item is taken from a shelf, black-box technology of the store determines who bought it with the help of relevant shelf's sensors and cameras on ceiling. Step 3 - The item is being added to the detected user's virtual cart.
Alternative Flow	Step 3 - If the customer taking the item is detected correctly and added to that customer's virtual cart but the product is not at that customer when (s)he leaves the shop, the user can remove it from virtual cart. Step 4 - When a removal happens, IT Staff is informed and staff members decide whether the removal is appropriate or not according to camera records.
Exception Flow	If the system is not able to detect who has taken the item due to system failure or ethical issues, then the system sends an error to staff and staff members take over.
Postconditions	Item is added to detected customer's virtual cart.

Table 3: Make decision of who bought the item

Figure 24: Activity Diagram of "Make Decision of Who Bought the Item" Function

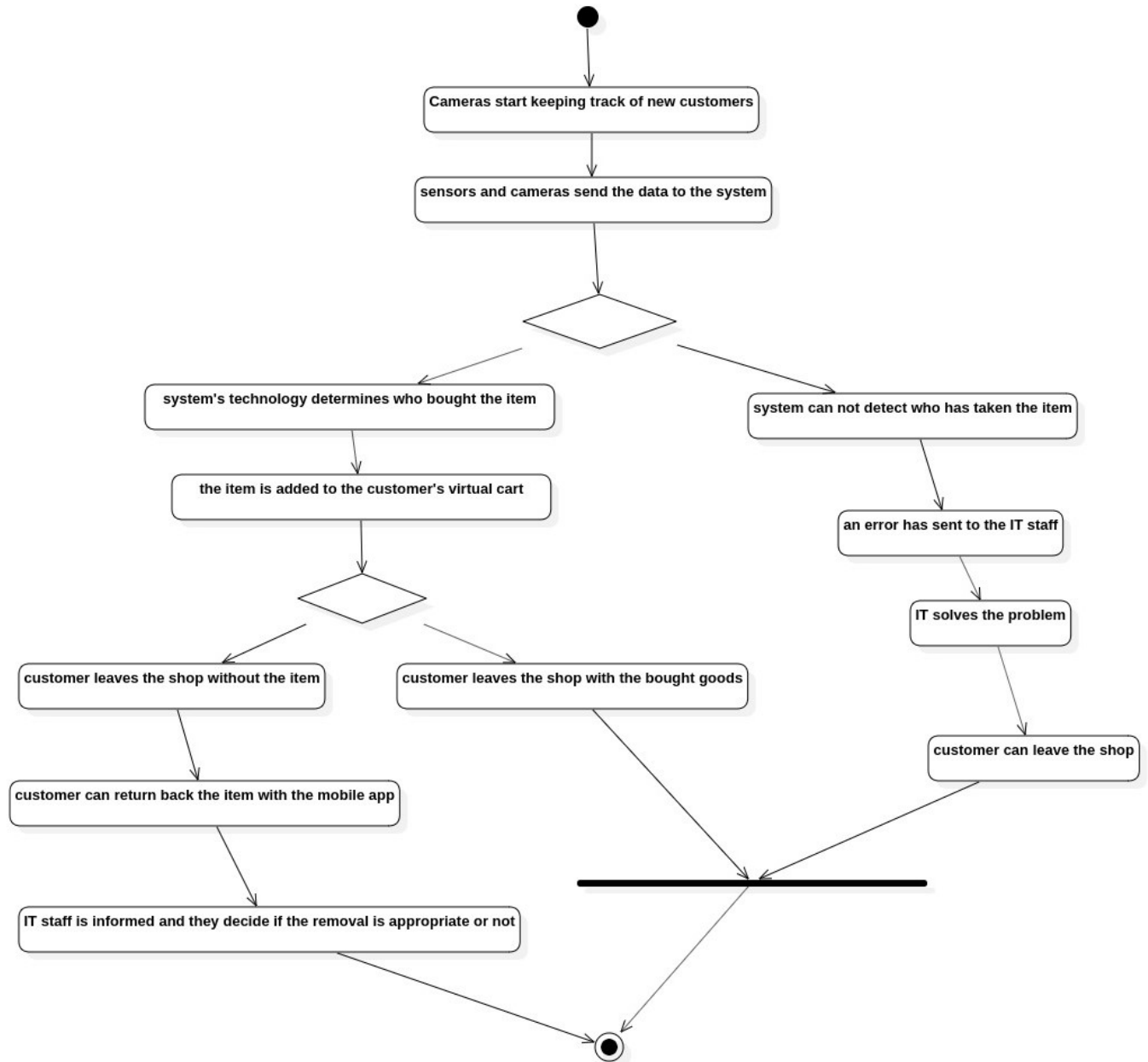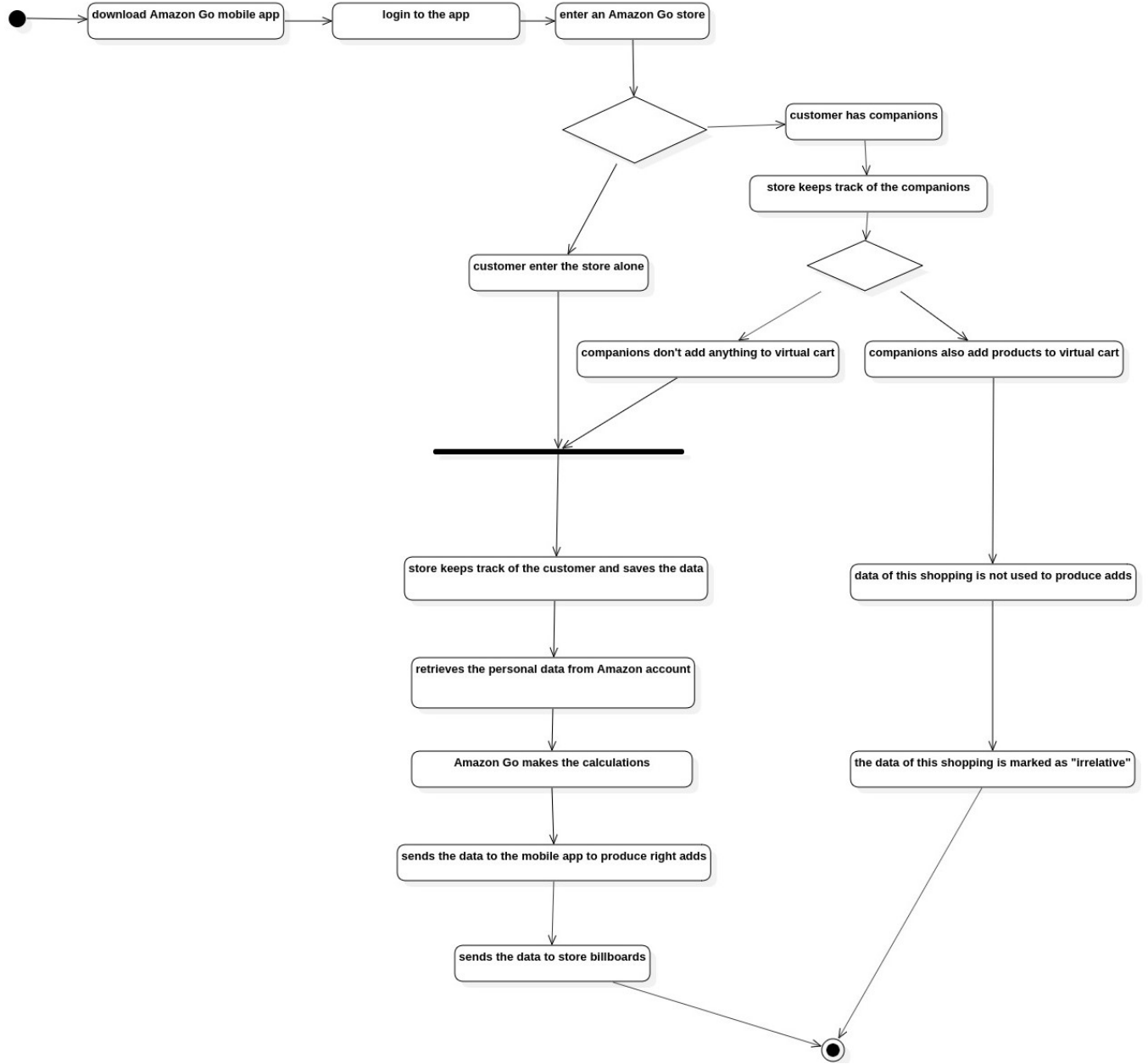| Use Case Name	Produce personal advertisements
Actors	Database, Store, Amazon Account, Mobile App
Description	The data retrieved from customers' Amazon account and examined by store is collected in the database, Amazon Go blackbox technology produces personal advertisement technology using this data. Mobile app and store is used to broadcast the advertisement.
Data	Personal data as customer interests, ages, genders, income level, the time they take in each aisle and their purchase history
Preconditions	None (Stepping into Amazon Go, or having an account is more than enough.)
Stimulus	Start using Amazon Go app
Basic Flow	Step 1 - Customer downloads the Amazon Go app, and logs in with Amazon account. Step 2 - Customer enters an Amazon Go store with the aid of mobile app. Step 3 - Store technology keeps track of the customer, saves customer's path and movements,the time taken to decide and in the each aisle. Step 4 - Amazon Go technology retrieves personal data and interests from the customer's Amazon account, store examines the customer's behaviours in detail, and this collection of data simultaneously sent to the database. Step 5 - The blackbox technology makes the necessary calculations and sends the results to store billboards in the aisles which the customer currently in and mobile app. Step 6 - Customer encounters personalised ads on the billboards and in the mobile app.
Alternative Flow	Step 2 - If with a mobile app, multiple customers enter the store Amazon Go, marks every companion with the same account name. Step 3 - Store technology keeps track of account holder and the companions, saves their path and movements,the time taken to decide and in the each aisle. Step 4 - Basic flow works for the account holder. Step 5 - The companions don't buy anything or add anything to virtual cart. Step 6 - Store analyzes the behaviours of the companions and creates advertisements based on their locations in the store and time they take in the aisles. Step 7 - The data collected by store about the companions is not saved in the database and deleted immediately after they left the store.
Exception Flow	If the companions cause a product to enter to the virtual cart, even though they don't buy it Amazon Go do not use any data to the related shopping and deletes the retrieved data from the database as the companions' purchase may lead to miscalculations for the personalized ads.
Postconditions	Personalized ads increase the profit.

Table 4: Produce personal advertisements

Figure 25: Activity Diagram of "Produce Personal Advertisements" Function

Use Case Name	Entrance
Actors	Customer, Store, Mobile App
Description	User who has the Amazon Go mobile app walks into the store.
Data	-
Preconditions	Having a functioning mobile app and Amazon Go-QR Code
Stimulus	Scanning the QR Code to the gate machine
Basic Flow	Step 1 - Download the mobile app and login with the Amazon account
	Step 2 - Scan the Amazon Go-QR Code to the gate machine.
	Step 3 - Gate opens and lets the customer in.
Alternative Flow	-
Exception Flow	If the QR code does not function gate does not let the customer in.
Postconditions	The customer enters the store.

Table 5: Entrance

Use Case Name	Exit
Actors	Customer, Store, Mobile app
Description	Leaving the store with the bought goods.
Data	The data of the virtual cart is transferred to the receipt.
Preconditions	Making a transaction of 1$.
Stimulus	Awake the gate sensors.
Basic Flow	Step 1 - When a customer is leaving the store, gate sensors determine the customer.
	Step 2 - Transaction payment area tries to make a transaction of 1$ from the leaving customer's virtual cart.
	Step 3 - After making the transaction, the customer leaves the store.
Alternative Flow	-
Exception Flow	Step 3 - If the transaction does not occur, the gate does not open and does not allow the customer to leave the store.
Postconditions	The customer is outside of the store.

Table 6: Exit

Use Case Name	Payment
Actors	Mobile App, Amazon account
Description	When a customer leaves the store, the customer's Amazon account is charged and (s)he is sent a receipt.
Data	The goods bought and their prices
Preconditions	Having an Amazon account and shopping.
Stimulus	Leaving the store.
Basic Flow	Step 1 - User passes from the transaction payment area.
	Step 2 - The customer's Amazon account is charged by 1$.
	Step 3 - User leaves the store.
	Step 4 - The rest of the bill is charged from the customer's Amazon account.
	Step 5 - The customer is sent a receipt.
Alternative Flow	-
Exception Flow	Payment is not rendered, and the customer has to deal with bank's policies.
Postconditions	The products on the customer's virtual cart is paid.

Table 7: Payment

Use Case Name	Add products to virtual carts
Actors	Store, Mobile app
Description	When a user picks an item from a shelf, the product is added to the customer's virtual cart.
Data	The details of the products in the virtual cart
Preconditions	Customer's being close to the related shelf.
Stimulus	Customer's taking a product from a shelf.
Basic Flow	Step 1 - Customer takes an item from the shelf. Step 2 - Item is added to the virtual cart. Step 3 - As long as the item has not put back to the shelf, it remains in the virtual cart.
Alternative Flow	Item is put back to the shelf and removed from the virtual cart.
Exception Flow	If a customer picks up an item and then gives it to another customer, the item is not removed from the virtual cart. The customer who takes the product from the shelf is charged.
Postconditions	Virtual cart is updated.

Table 8: Add Products to Virtual Carts

Use Case Name	Keep statistics
Actors	Database, Store
Description	Information about customers' shopping history and behaviours in store are kept in the database.
Data	-
Preconditions	There should be customer(s) in the store. Their doing shopping is a plus.
Stimulus	Any user in the store
Basic Flow	Step 1 - Customer enters the store. Step 2 - Cameras keep track of the customer while (s)he is in store. Step 3 - Sensors detect the items that customer has taken. Step 4 - System writes all these information to the database.
Alternative Flow	If customer has companions and companions picks up some products, the details of this shopping is marked, since the companions' behaviours can be misleading for the statistics.
Exception Flow	-
Postconditions	System enlarges its database.

Table 9: Keep Statistics

Use Case Name	Keep track of customers in the store
Actors	Store, Customer
Description	Using the hardware in store, the system keeps track of customers' moves.
Data	The coordinates of the customers and the time taken in the each aisle and in front of the each section.
Preconditions	There should be at least one user in the store.
Stimulus	A user's entering from the transaction area.
Basic Flow	Step 1 - A user enters the store passing by transaction area.
	Step 2 - Cameras in the store detects the user.
	Step 3 - Cameras having different angles record the customer's movements until (s)he leaves the store.
	Step 4 - If multiple users entered the store with the same account, system keeps track of the others, too.
Alternative Flow	-
Exception Flow	-
Postconditions	This data is recorded to database for statistical and marketing purposes and used while detecting whom to add the product.

Table 10: Keep Track of Customers in the Store

Use Case Name	Analyze which item is taken by the customer
Actors	Customer, Store
Description	An item is taken from the shelf by a customer
Data	The information of the section of the product and the data from the cameras
Preconditions	There is a customer near the section.
Stimulus	The item is taken by a customer.
Basic Flow	Step 1 - A customer picks up an item from the shelf
	Step 2 - The weight detectors in the shelf weigh the product, the cameras send the data to the Amazon Go system
	Step 3 - System decides which item is being taken
Alternative Flow	-
Exception Flow	System fails to decide which item is taken and an error thrown to the IT Management System.
Postconditions	Item is eventually added to the virtual cart.

Table 11: Analyze which item is taken by the customer

Use Case Name	Use Statistics
Actors	Mobile App, IT Staff
Description	The statistics in the database can be seen and used by IT staff.
Data	All the information that is processed in the Amazon Go system, customer accounts, personal data, shopping behaviours etc.
Preconditions	The statistics are saved in the database.
Stimulus	IT Staff make use of statistics and controls the store stocks.
Basic Flow	Step 1 - The data in the database is reviewed by IT staff.
	Step 2 - According to the statistics the number of necessary products is determined.
Alternative Flow	-
Exception Flow	If there is an error in the database, the statics cannot be used and the IT Staff is informed.
Postconditions	The data is also can be used for other development and marketing purposes.

Table 12: Use Statistics

Use Case Name	Handle errors
Actors	IT Staff
Description	IT staff handles the errors to make Amazon Go function properly.
Data	The time and description of the error
Preconditions	Every Amazon Go store must have IT staff.
Stimulus	An error occurred in the system.
Basic Flow	Step 1 - An erroneous input corrupted the system or affected its decision mechanism. Step 2 - IT staff is informed about the error by a notification. Step 3 - IT staff handles the error by either finding and editing the source of the error or deciding instead of Amazon Go.
Alternative Flow	Step 2 - If the notification system doesnot function, IT staff is informed by other staff members or customers. Step 3 - IT staff handles the error.
Exception Flow	If Amazon Go IT members are not able to solve the problem, the system corrupts for some time.
Postconditions	Amazon Go continues to function properly.

Table 13: Handle errors

Use Case Name	View system logs
Actors	IT staff
Description	IT staff can see the logs in detail. Information like how many customers are in the store at that moment or who entered when is readable by IT staff.
Data	System logs
Preconditions	The IT staff member must be authorized.
Stimulus	An IT staff member requests to read the logs.
Basic Flow	Step 1 - The request gets to the database with an annotation of the time interval asked. Step 2 - Logs are listed chronologically and written to an output file.
Alternative Flow	Step 1 - If logs are asked to have some spesifications, IT staff makes the request accordingly. Step 2 - Logs are listed as wished and written to the desired file.
Exception Flow	If there is an authorization or connection problem, IT personnel is notified.
Postconditions	System logs are visible to the IT staff member.

Table 14: View system logs

3.3   Usability requirements

- Amazon Go mobile app should be easy to use for people of all ages.

- Users should be able to check their previous shopping details such as receipts and how much time spent whilst shopping.

- Consumers in the store should be able to easily contact with the IT Staff for the questions regarding the software.

- IT Staff should be using a management system that lets staff to conveniently conduct the necessary operations.

- Consumer should be able to state their satisfaction or dissatisfaction of using the system and the app with a survey.

3.4 Performance requirements

- In an Amazon Go store there must be at most 3 people per square meter for system to be able to make accurate calculations.

- The system should decide to what a customer picked up (unless it is a problematic situation which requires human decision techniques) in at most 4 seconds.

- There should be at least 5 database backups to keep the system reliable 99.97%

- The sensors in the shelves have to be sensitive enough to give accurate results for the 95% of the activities.

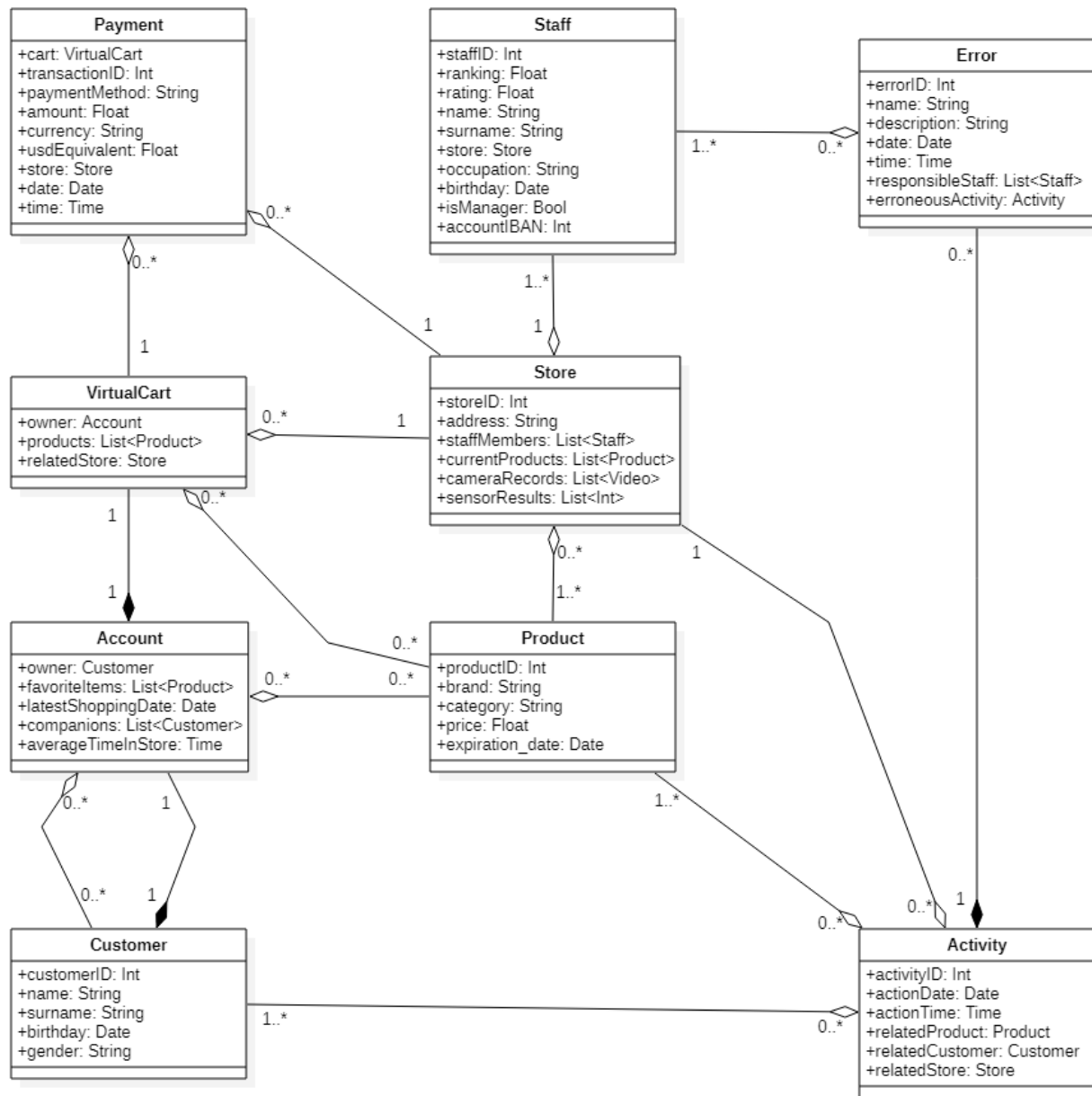## 3.5 Logical database requirements

Figure 26: Amazon Go Logical Database Requirements Class Diagram

- Payment class should keep the information of virtual cart making the payment, date and time, in which store that payment happened, payment method, paid amount and currency and their USD Equivalences, and transactionID, as primary key.

- In VirtualCart class, we have the attributes owner account, products currently in virtual cart and current store that the user is in. VirtualCart's primary key is account so customerID.

- In Account class, we keep owning customer of that account, favorite products, latest shopping date and average time spent in the store of related account, due to marketing purposes. Moreover, we keep the current companions related with that account due to let the companions do shopping and add items taken by these companions to related account's virtual cart. Account's primary key is owner so customerID.

- In the Customer class, we have the attributes customerID as primary key, name, surname, birthday and gender in order to have a general information about customer. We also use them for marketing strategies.

- Staff class has the attributes staffID as primary key, staff ranking, name and surname, store that (s)he works in, his/her profession, birthday and an IBAN number for salary account.

- In Store class, we keep the information storeID as primary key, address of that store, staff members working in that store and products in that store.

- Product class has productID as primary key, brand, category and price of the product and expiration date, if any.

- In Error class, we keep errorID as primary key, name and description of the error, date and time that the error occurred, staff members taking/will take care of that error and the action, activity, causing the error.

- Activity class has the attributes activityID as primary key, date and time and related product, customer and store.

- One payment is happened in one store, but there could be zero or many payments happened in the same store.

- One payment is made with one and only virtual cart, but there could be zero or many payments happened with the same virtual cart.

- Each virtual cart is connected with one account. That's why there is a one-to-one relationship between virtual cart and account. Moreover, if an account is deleted, the virtual cart connected to it will also be deleted.

- There may or may not be products in a virtual cart. Furthermore, a kind of product can be in more than one virtual cart. Therefore, these two have a many-to-many relationship.

- A virtual cart is related with only one store, but there might be zero or many stores related with any virtual cart.

- Each account is connected with one customer. If a customer is deleted, the account connected to that customer will also be deleted.

- There's also a many-to-many relationship between account and customer. A customer could bring zero or many companions attached to that user's account.

- There may or may not be product(s) aggregated to account as favorite items, but a product could have relation with more than one account.

- A staff is part of a store. There should be at least one staff member working for a store. In addition, a staff could work for one and only store in the system.

- Products are also part of a store. There should be at least one product in a store, and several stores could have the same product. Yet, there could be a product that any of the stores does not have.

- Each error should be handled by at least one staff and a staff could handle with zero or many errors.

- An activity might have zero or many errors. Yet, each error has at least one activity and if that activity is deleted from the system, the error will also be deleted.

- An activity is happened in one and only store. Nevertheless, there could be zero or many activities occurred in one store.

- An activity is happened with one or more product(s). Yet, there could be zero or many activities having a specific product.

- An activity is happened with one or more customer(s). Yet, there could be zero or many activities related to a specific customer.

- Staff members cannot see products in a virtual cart. Yet, they can see products in payments.

- All the attributes in product and store are visible to any class in the system.

- Errors are visible only for responsible staff but nobody else.

- Account is visible for the owning customer but not other customers, and staff members with the occupation including keywords *data, IT*.

- Payment is visible to the customer having the same customerID with payment's cart's primary key, customerID, not to the other customers.

- An activity can be used by related product, customer, store; error having that activity and staff able to see the error.

- Staff information is not reachable from any other classes.

- A staff member's accountIBAN is visible only for the staff whose occupation is *accountant*.

- Ranking and rating of a staff member is visible to anyone, but not changeable by anyone.

3.6   Design constraints

From the experiences in some of the stores, it can be said that there is a limit in the number of people who are currently in the store. As the number of customers increases the store encounters problems of deciding who bought what and analyzing the behaviours of the customers as well as making erroneous assumptions. Sensors and cameras are all technologically have a limit. These limitations greatly affect the project's limitations.

This software is implemented to ensure that customers are not spending any time during check out. However some states in the USA, accepts the cashierless Amazon Go stores with just walk out technology are being discriminating against low-income people. This states have banned the cashierless stores. Therefore in the Amazon Go stores that are located in that states customers are paying with cash. This regulations is a limiting factor for Amazon Go system.

3.7 Software system attributes

Amazon Go system has more requirements that are not functional that can be listed as following:

- **Reliability**

  - The system should check the product stocks every hour, to be more accurate. If anything is missing or not correct information should be edited by IT Staff.
  - The receipts that sent to customers should be approved by the customer and at 24.00 everyday the receipts should be archived for any case they can be needed.
  - IT Staff should take notes of the daily errors and prepare reports everyday.

- **Availability**

  - Amazon Go should be available and accurate even when the store is crowded and calculation is troublesome.
  - The system errors should be checked and dealt instantly as Amazon Go promises customers to reduce the time spent shopping.
  - Amazon Go should be available to customers with low-battery smartphones, the app should be not using many background processes that drain battery quickly.

- **Security and Privacy**

  - Consumer information such as personal information, monthly expenses, interests shouldn't be shared with third parties, and for the cases they are used for statistics any data regarding the customer should not be included.
  - Any camera record should be published except the cases of crime.
  - The payment information, such as credit card numbers and account numbers should be carefully protected.
  - IT Staff should regularly check the system, do penetration tests and keep an eye out for possible cyber-attacks.

- **Maintainability**

  - Software should be updated regularly and documentation should be detailed.
  - Error logs should be archived with comments in order to feed the machine learning processes and ease making decisions for IT Staff.
  - IT Staff should always observe the system for bugs and other leakages.

- **Portability**

  - The app should be able to run in a large variety of operating systems such as Tizen, Plasma Mobile, LuneOs besides Android, Windows Phone and iOS.
  - Amazon Go should be able to accept different payment methods even the ones that are not popular throughout the USA, to be a part of the international market.

3.8   Supporting Information

The survey that conducted by Shorr Packaging Corporation which 1000 Americans have participated asks the question "Are We Ready For Amazon Go?". A part of the result is as the following:

84% of respondents said that they see Amazon Go as a type of grocery shopping experience that they would **enjoy more** than traditional grocery shopping.

NEARLY 75% of the people surveyed said they would be either **extremely likely or very likely** to shop at an Amazon Go store if one opened up close to where they live.

OVER 25% said that they would even **pay more for grocery products** if it meant that they didn't have to wait in line at check out.

Figure 27: Statistics

This statistics show that this software for Amazon Go is very likely to be successful.

Amazon Go also has a subproject, named Amazon Go Grocery, located in Seattle with just one shop for now. It uses the same system but a different shopping concept: it is not a regular shop but grocery.

4   Verification

5   Appendices

5.1   Assumptions and Dependencies

5.2   Acronyms and Abbreviations