Developing a humanless convenience store with AI System

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Abstract. The term artificial intelligence (AI) is no longer a foreign term. It is an ever-growing form of intelligence shown by machine. It is important for retail store owners to adapt to these changes in order to further expand their businesses and profits. For this research study, the focus is primarily based on university students and staff. This system comprises two key parts, namely the Customer’s Application and the Smart Shelf. The Customer’s Application provides a platform for the customers to perform self-checkout through online transactions. The Smart Shelf assists the retail store owners in managing inventory and providing a smooth flow in the business. Within the Smart Shelf, the face recognition helps to provide additional security features and help retail store owners keep track of the number of customers who have successfully registered. The Internet of Things (IoT) allows the retail store owners to monitor and manage their stores without the need to be physically present at the store. The Customer’s Application and the Smart Shelf allow customers to save time as queuing time can be eliminated while embracing a safe and secure shopping experience. This system enables the retail store owners to maximize their profit as it helps in their inventory management and the digitized system will not only save time but will have higher accuracy, minimized mistakes, thus leading to more efficiency. Eventually, they will have the upper hand against their competitors and eliminate the need for additional labour costs.

1. Introduction
The term artificial intelligence (AI) is not a foreign concept. The history developed around AI has its significant difficulties, lavish hopes and even disheartening let-downs. However, with the industrial revolution entering its Fourth Industrial Revolution, AI has been the focus. Analytics suggested that at long last, AI is ultimately bringing benefits to businesses [1]. All the major players that make AI are more reliable and ready compared to previously. Technological breakthrough allows more powerful computing, the complexity of algorithms is growing, and the enormous data generated every day is now available to be fed to AI.

World-leading companies dealing with the digital world such as Google and Baidu are investing [2] large sum of money on AI. AI gives birth to the possibility of machines to learn, experience and self-regulate new inputs to execute human-like work. AI will be the topic of discussion in the digital world for the next few years to come. This clearly implies that with the proper implication of AI, the growth or success of any sector or field would rise to another level in terms of both wealth and productivity.

In today’s world, AI is integrated into almost any kind of gadgets or electronic devices. When one deep dive enough into the researches and studies on AI, ground-breaking, and state-of-the-art technology with AI can be created and developed such as an autonomous vehicle which may reshape how consumers behave [3]. It is of utmost importance to study the beneficial impacts on the mutual relationship between...
AI and humans. AI is merely a tool that can be fully utilized and optimized by the hands of humans and AI has the capability to bring humans’ abilities to greater heights. However, being an emerging technology, unpredictable challenges may occur, thus fortifying the need to perform further researches and studies regarding AI to have similar capacity as human when it comes to solving problems [4].

One of the major problems with large retail stores that attract a sizeable crowd is the extremely long queuing time for checkout. To stand in line for a long time [5] with all the products and items can be frustrating, especially for those who have tons of work to accomplish within the day. This causes the customers to change location or even migrate to online shopping. Besides, retailers may tend to suffer from major losses due to stock surplus [6], which generally cause a reduction in profit margin. This leads retailers to initiate a stock clearance sale, selling everything at a relatively low price in order to remove the surplus and to minimize losses. Furthermore, more storage means more spaces are required which leads to additional costs to obtain those extra spaces. Additional workers must be hired and paid in order to organize and manage the warehouse [6]. Inventory management is essential to avoid wastage on expired goods when excessively stocked. However, these wastage, complications and obstacles can be easily overcome with the integration of AI [7] into the core of the retail store system.

An example could be seen through Amazon Go Just Walk-Out Technology [8] where the basic idea behind is to allow the customers to enter the store, take whatever is needed and leave as the prices of all the taken goods will be automatically billed to Amazon’s own mobile application. Based on a survey on Amazon Go, majority believe that the implementation of AI in retail would make Amazon Go a dominant competitor in the world of retailing in the near future as it completely eliminates the primary discontent with shopping which is the extensive queuing time for checkout [9]. This major breakthrough has changed the ways how public shop these days and has contributed in saving time especially in the busy world today.

The aim of this research is to design a simple cashier-less or a smart checkout system that allows university students and staff to shop conveniently. There are a few objectives that must be achieved in this research, namely, (1) to eliminate long queuing time when purchasing items especially during peak hours like lunch break; (2) to eliminate the need to use physical money; (3) to eliminate the need for additional labour costs, and (4) to construct a holistic system which can be set up easily at the lowest cost possible. Identifying the importance and benefits that AI contributes to the economy is vital.

1.1 Previous Studies
Being an emerging technology, the possibility of AI becoming the next digital frontier is heatedly discussed. Digital native companies such as Amazon made a big investment by acquiring Kiva [1], a robotics company that specializes in automated picking and packing for a whopping price of $775 million. This leads to a significant and highly potential return on investment. In Amazon’s case, under human workforce, it took approximately about 60 to 75 minutes to complete the “click to ship” cycle time. However, after the acquirement of Kiva, the cycle time dropped drastically to only 15 minutes. Besides Amazon, Netflix, an American media-services provider and production company, successfully achieved remarkable results when investing in AI [1]. With the algorithm used, Netflix can personalize suggestions and recommendations to all their subscribers, approximately 100 million, worldwide. This algorithm has successfully assisted their subscribers to rapidly search and determine the desired content. Another major contribution towards the growth of companies could be seen in YouTube. YouTube’s brain algorithm has allowed up to 70% of the videos uploaded to be found by viewers via recommendation without relying on subscriptions and links provided by advertisement or other viewers [10]. The trend of using advanced technology is increasing and has already significantly benefiting the industries.

Retailers that adopt AI into the foundation and essence of their business can clearly feel the positive, potential impact on their profit [11]. AI clearly provides tremendous competitive advantages not only in
terms of profit but also in terms of services such as delivery speed and product accuracy. However, noteworthy results can only be achieved by seriously dedicated companies where millions are invested such as in the case of both Amazon and Netflix.

1.2 Artificial Intelligence (AI) in Retail Store

AI can be represented as means that has the potential and capability to augment the acumen of the device to perform exceptional and instantaneous services and rectification [12]. AI is of paramount importance as it is changing the basis of how retailing works in today’s state-of-the-art world. Retailers can exploit the benefits provided by AI to improve and upgrade the retailer overall services. Powerful, giant retailers such as Walmart and Amazon have collected millions of data from their customers every day and by feeding and supplying all these data to AI, the AI is able to perform precise and accurate analysis such as predicting the customer’s behaviour, recommending and suggesting products desired by the customers, optimizing inventories, transportation and delivery of goods.

With greater forecasting accuracy [13], companies will benefit from an increase of profit as there will not be a need to purchase unnecessary products which would only consume precious space in the warehouse. The application of AI along with smart sensors and robotics is currently dominating not only the business world, but other fields as well. However, despite AI being a subject undergoing intense study, the adoption of AI is still in its primitive stage. This implies that it is a matter of time before AI could establish a notable impact towards retailing.

1.3 Internet of Things (IoT) in Retail Store

IoT which is also known as the Industrial Internet [14] is one of the latest emerging technologies which forms an idea of the World Wide Web of machines and the capability of devices to communicate with one another. This is due to the result of major technological advancements such as faster Internet speed, cloud computing, social media and so on which has reformed the world of telecommunication as we know today. Not every electronic can access the Internet. Therefore, the IoT is to compensate this disability by allowing the devices to exchange and transfer information from the physical world to the Internet. Millions and millions of data are being generated each day which needs to be scrutinized and processed in order to fully utilize all this information. IoT in retail is made possible with the assistance of not only the Internet but also the Radio-Frequency Identification (RFID). By tagging and labelling each product with RFID, the quality and reliability of a retail can be assured as it helps to enhance inventory accuracy and tracking, reducing the rate of errors, improve security and allowing the supply chain components to be visible. The application of RFID tag has assisted in boosting the overall efficiency of their logistics and businesses by reducing the risk of stock-outs when demand is high. For example, Decathlon, which is the world’s largest sports retailer, implemented the RFID tags onto their products. This led to an increase of 11% in sales within a year, July 2014 to July 2015. Since then, Decathlon has been using RFID tags, tagging almost every single product in order to further increase their sales efficiency.

Retailers suffer a loss of approximately 20% of sales [15] owing to customers seeking to find the items they would like to purchase particularly in a humongous or an unorganized store. With almost a non-existence assistance from the employees, the burden of pinpointing the whereabouts of the desired items can be an extremely drawn-out process, physically taxing and mentally exhausting. However, with the rapid, exponential growth of recent technologies especially in IoT, new approaches on indoor positioning and information retrieval have brought forth a variety of possibilities of turning the tides which will transform the losses to profits.

1.4 Formally Suggested Systems

A system called a smart supermarket shopping guide system [16] was proposed. The important key point to ensure the success of this system is product classification and identification. Once customer selects the goods, the customer can then select navigation which will display the location of the goods on the device.
A similar concept of a smart shopping cart which will be able to communicate with the shopping mall system creating a smart shopping mall [17] was also proposed. The design consists of a facial recognition function to detect and identify their customers, thus allowing extra services and information to be provided to the customers based on their previous purchases.

A design with an Automated Inventory Management [18] which is based on the combination of IoT and Cloud Computing was proposed. This will allow high efficiency in ordering, monitoring, tracking and purchasing. The end goal of this design is to develop an interactive shopping ecosystem which allows the customers to instantly locate the products and not queue in line for checkout.

2. Methodology and Work Plan

The main concept of this system can be divided into two main parts, namely the Customer’s Application and the retail store Smart Shelf. The Customer’s Application was built by referring to a sample open-source code [19]. By referring to this sample, the Customer’s Application was developed with a few minor adjustments to fit into this research system’s requirement. The criteria for the Customer’s Application were to have at least a login page, a profile page for customers to interact with and a payment system. Modifications were made to meet the objectives of this project.

The second main part was the retail store Smart Shelf which can be further broken down into several parts, namely the face recognition system, ultrasonic sensor and Raspberry Pi. This part was built based on two different sources for references. The face recognition system was developed with reference to an open source code found on the Maker Pro website [20]. The IoT system was created using the ultrasonic sensor and Raspberry Pi. The concept was based on an open source project provided by Cloud4Rpi. Enhanced modifications were performed accordingly in order to meet the criteria of this study. The criteria for the Smart Shelf were to be able to identify and recognize faces using facial recognition and allowed owners to monitor the sales and amount of products on the rack without the need to be physically present in the store.

For research purposes, a few assumptions were made when developing this system. The assumptions were:

- Only one type of product was to be stored on the rack.
- Only one customer at a time could open the door.
- Customers were not able to refund or exchange the purchased products.

The next subsections explain how each major component were built and why they were built in such a way.

2.1 Flask

Flask is a micro web framework which uses Python as its programming language. Flask was used to build the Customer’s Application in this study. Flask was used in this study simply because it supports Python and is an open source software. A few modifications were done to the original source code [19]. Additional input included options to allow customers to enter the number of products taken and the prices were added into the customer’s profile page in the Customer’s Application. Furthermore, Stripe API was also added into the Customer’s Application to enable online payment.

2.2 Face Recognition

The face recognition was built using Haar Cascade and Local Binary Patterns (LBP) Cascade. These are classifiers that can be found in OpenCV. Haar Cascade classifier is mainly used to detect objects after it is trained based on the set of images provided. The Haar Cascade classifier was used for the following reasons:

- High detection accuracy.
- Low false positive rate.

Local Binary Patterns Histogram (LBPH) face recognizer was used for the following reasons:

- Fast computational time.
- Require shorter time to train.
Both Haar Cascade and LBP Cascade are open source and free for commercial use and both support Python.

The PiCam, a camera module dedicated to the Raspberry Pi, will then detect and capture the customer’s face using Haar Cascade classifier and LBPH face recognizer is then trained to recognize the customer’s face.

2.3 Raspberry Pi 4, Ultrasonic Sensor and Cloud4RPi

Raspberry Pi 4 is a mini-sized computer and was used in this project mainly because it has a 4 GB RAM model which allows more heavy-duty application to run smoothly. Besides, unlike the Arduino, it supports Python which was the main programming language used throughout this project. Lastly, it also comes with GPIO pins which enables easy connection for the ultrasonic sensor.

Ultrasonic sensor was used as the proximity sensor instead of the infrared sensor. This is because the performance of the ultrasonic sensor is not affected by external factors such as light or dust which will naturally exist when placing the ultrasonic sensor in a shelf. The ultrasonic sensor used was HC-SR04 Ultrasonic Proximity due to its lower cost.

Cloud4Rpi is an Application Programming Interface (API) which allows the user to control and monitor any IoT devices connected to it. For this project, the Raspberry Pi 4 was connected to the Cloud4Rpi. Cloud4Rpi provided a cloud server for the Raspberry Pi 4 to send information to be stored in the cloud server. The information was then displayed through the dashboard widgets provided by Cloud4Rpi.

The interaction between the HC-SR04 Ultrasonic Proximity sensor, Raspberry Pi 4 and Cloud4Rpi is based on an article published on Cloud4Rpi [21]. The source code is obtained from GitHub. Thorough modifications were made after detailed studies to ensure that the project’s aim is achieved and comply to the needs of this research.

3. Results and Discussion

The four components – Flask, face recognition, Raspberry Pi and Cloud4RPi are needed to finalize the entire project. These components come hand in hand with each other to ensure a smooth flow in the system.

3.1 The System’s Built and Functionality

There were a few assumptions and criteria needed to be taken into consideration when developing the system’s built and functionality.

Assumptions:

- For research purposes and simplicity, only one type of product will be stored on the rack.
- Only one customer at a time could open the door.
- Customers are not able to refund or exchange the purchased products.

Criteria:

- The ultrasonic sensor has been installed to continuously detect the distance between the ultrasonic sensor and the product on the rack.
- The Raspberry Pi would send data to the cloud when a sudden change in distance is detected.

3.1.1 The Customer’s Application

The goal of this web application is to establish a communication in the form of online transaction between the customers and the store. With this web application, the need to use any form of physical cash is eliminated. Furthermore, the retail store owners can keep track on the number of customers who have registered.
3.1.2 The Retail Store Smart Shelf.

The product is kept in an enclosed shelf where the doors are locked using a solenoid lock. The door is also installed with a PiCam. A face recognition system is used as the key to unlock the shelf doors and to allow only those customers who had successfully registered with the store to do so. In other words, anyone can enter the store to look around or to even do window shopping, however, only registered customers can unlock the solenoid lock of the shelf to purchase. Inside the shelf, a rack housing the product is installed with an ultrasonic sensor in order to detect the distance between the ultrasonic sensor and the product.

3.2 Customer Application System Flow (Customer’s Perspective)

A flowchart to demonstrate how the system flows is shown in Figure 1.

![Flowchart](image)

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**Figure 1.** Overall system flowchart.
For simplicity purposes, a front-end registration option is not developed. Therefore, the registration has to be done through the back-end. A simple registration where the user is only required to give a username and a password. The users can then proceed to login. Simplicity is prioritised as many users tend to feel troublesome if detailed registration is needed. If they feel the registration process is time consuming, they may leave and choose elsewhere to shop instead. The interface of the login page is shown in Figure 2.

![Figure 2. Customer’s application login page.](image)

After the user have logged in, the user would be greeted with their username along with their respective ID number in brackets as shown in Figure 3 below. From here on, the users could easily enter the number of items taken and the price of each item. The final price would be displayed after pressing the ‘CALCULATE’ button and users could then proceed to ‘Pay with Card’.

![Figure 3. Customer’s application profile page.](image)

Stripe is a software that integrates payment platforms with applications to enable users to monitor their business revenue. By using Stripe API, developers can utilize the functionality of Stripe, allowing for testing and debugging before officially launching the application. A simple transaction system is
implemented into the customer’s web application using Stripe API which allowed customers to perform online payment without the need to use physical cash.

![Payment system using stripe API.](image)

**Figure 4.** Payment system using stripe API.

### 3.3 Overall System Flow (Retail Owner’s Perspective)

This section can be further broken down into three different subsections that discuss the system flow for the Customer’s Application, the system flow for the Smart Shelf and the application of Internet of Things in this project.

#### 3.3.1 The Customer’s Application.

Once a customer successfully performed an online transaction through Stripe API, analysis on the store sales could be made by the retail store owner. A dashboard widget is provided by Stripe API as shown in Figure 5 below to help with the analysis. With the help of all this information such as total gross volume, net volume of sales and so on, retail store owners can subsequently plan out their strategies and budget plans to future proof their store.

![Stripe API dashboard widget for owners.](image)

**Figure 5.** Stripe API dashboard widget for owners.

#### 3.3.2 The Smart Shelf

The purpose of the Smart Shelf is to assist the retail store owner in monitoring their stocks. Especially when entering the boundary of humanless surroundings, ethical issues will become the most concerning issue. Example, in a humanless store, how honest and well-mannered can a customer be without any human supervision? Despite the advancement in technology, precautionary steps must still be taken in
order to address any unethical issues such as theft and dishonesty. In this case, a face recognition system is installed to monitor when and which customer came to purchase the product. This helps to enhance the security system.

The type of shelf used in this project is a shelf with a door. The door itself is installed with a solenoid lock and a camera module namely the PiCam. However, due to monetary issues, a simple LED is used to replace and represent the solenoid lock. When the LED lights up, it signifies that the door is unlocked and vice versa. The Raspberry Pi is installed with the face recognition module. Therefore, to unlock the doors, the PiCam which is connected to the Raspberry Pi will perform facial recognition to identify and recognize customers who has already registered an account with the retail store. An open source face recognition module called Haar-Cascade detection is used for this purpose. The sample of the shelf is shown in Figure 6 below.

![Figure 6. SolidWorks drawing of the shelf with the location of the PiCam.](image)

On that account, with their full consent, the customers would have to register their faces along with other basic information such as their names. Similarly, to the Customer’s Application, the registration is to be performed through the back-end as shown in Figure 7. During the registration of the customers’ faces, the system would first ask the user to enter their name. After typing the name and pressing enter, this would trigger the PiCam to activate and a new window would appear to detect customer standing in front of the camera. The green box around the customer’s face basically signified that a face was detected which the system would automatically capture a total of 30 images per customer and stored in the store’s database. Only the area within the green box is captured and stored as the internal features of the face such as the eyebrows, eyes, mouth and nose. These parts of the face are vital in the face recognition process.

![Figure 7. Registration of the customer’s face.](image)

Once the registration is successful, customers could then proceed to unlock the door. It is to be noted that the face of the customers must be directly facing straight to the PiCam in order to allow the facial recognition system to recognize the face with higher accuracy. When a customer’s face is successfully recognized and identified as shown in Figure 8, the door would automatically unlock. In this project, the
LED which represents the solenoid lock, would light up. In other words, the solenoid lock would be unlocked. With this face recognition, the retail store owners would be able to monitor who is purchasing their products. Furthermore, any irregularity on the total sales and dishonesty from the customers could be easily identified through all the information sent to the cloud platform which will be explained in the next section.

Figure 8. Face recognition.

3.3.3 The Application of Internet of Things. In this section, the flow and working principle on how information is sent to the cloud are explained. A flowchart is constructed as shown in Figure 9 to illustrate how the sensors and cloud interacted with each other to send information to the cloud.

Figure 9. The flowchart of the system’s logic.

Firstly, how to constantly measure the amount of product left on the rack. The HC-SR04 ultrasonic proximity sensor is used to detect the distance between the ultrasonic sensor and the products. A simple custom rack is designed using SolidWorks 2018 to illustrate the placement of both the ultrasonic sensor and the product as shown in Figure 10. This rack would then be placed inside the shelf shown earlier in Figure 6.

Figure 10. Rack and placement of the ultrasonic sensor illustrated using SolidWorks 2018.
The information sent to the cloud is triggered through any change of event detected by the ultrasonic sensor. The condition is the distance threshold. All the results are illustrated using SolidWorks 2018 along with a screenshot of the dashboard widget provided by Cloud4Rpi. The various thresholds are as followed:
Distance of the product from the ultrasonic sensor is greater than 2 cm but less than 8 cm. This means that the rack quantity is adequate. The retail store owner would be able to observe these results through their screen either at home or at their store. Result is shown in Figure 11.

| Distance    | 5.00                       |
|-------------|----------------------------|
| Status      | ADEQUATE                   |
| LEDRelay    | false                      |
| ObjectLevel | 62.00                      |

Figure 11. Information showing that the rack quantity is adequate and LED relay false were sent to the cloud and was displayed in the dashboard widget.

Distance of the product from the ultrasonic sensor is greater than 8 cm but less than 10 cm. This means that the rack quantity is low. This serves as an early warning for retail store owners to refill the products in order to prevent stock-out especially during peak season for certain products where demand is high. Result is shown in Figure 12.

| Distance    | 8.20                       |
|-------------|----------------------------|
| Status      | SHELF ITEM IS LOW          |
| LEDRelay    | false                      |
| ObjectLevel | 23.00                      |

Figure 12. Information showing that the rack quantity is low and LED relay false were sent to the cloud and was displayed in the dashboard widget.

Distance of the product from the ultrasonic sensor is greater than 10 cm. This means that the rack is empty. In this state, the LED would light up, signalling the owner to refill the rack. Furthermore, the system’s terminal would be continuously receiving and showing the alert message shown in Figure 14 until the empty shelf is dealt with. Results were shown in Figure 13 and Figure 14.
Figure 13. Information showing that the rack is empty and LED relay true were sent to the cloud and was displayed in the dashboard widget.

![Image]

**Figure 14.** Back-end server alerting owner that the shelf is empty.

To summarize it, when the distance of the product from the ultrasonic sensor is less than 8 cm, this means the rack is stocked whereas if the distance is greater than 10 cm, this indicates that the rack is empty. This valuable information would be sent to Cloud4Rpi which will then be displayed in the dashboard widgets, allowing retail store owners to know whether the product is stocked or not. This allowed retail store owners to know when to restock without the need to constantly check and prevent any loss of income especially when a customer failed to purchase due to empty racks. Furthermore, the dashboard widgets could show the retail store owner regarding the sales trend of the product, whether the sales of the product are increasing or stagnant.

3.4 Benefits to the Customers

One of the most significant benefits provided by this project is timesaving. The Customer’s Application provides customers with the option to perform self-checkout. Therefore, customers can avoid queuing up for long check-outs at the cashier. Furthermore, in this era of technological advancement, people are always having their smartphones on their hands. With the idea of using an online transaction via a web application, customers can easily perform payment via online transaction through their phone instantly after picking their desired products. This will eliminate the inconvenience for customers to find their wallet and paying with physical cash and receiving any available balance. Cashless society is the current trend [22][23]. Cashless shopping may also tend to be safer. Going cashless is the latest trend especially during the current coronavirus pandemic that the world is facing.

This project provides a secure environment for customers. If the retail store is to be filled with all the smart shelf presented in this project, the entire store would be filled with cameras. In a way, those cameras act as closed-circuit television (CCTV). This can greatly reduce the potential of any snatch theft or robbery from occurring [24]. Furthermore, this project’s overall system eliminates the need to use any form of physical cash, thus hindering the need for the customers to fish for their cash or bank cards. This, too, reduces the risk of the customers themselves to be potential targets for any criminal activities.

A more merchandised store apparently will attract customers, knowing that their product will have a high chance of being in stocked. An effective method in monitoring the inventory storage is vital [25]. With the inventory management implemented together in this study, retail store owners and any working staffs will know when the rack stock is running low or empty and thus restocking them efficiently. Business performance will be vastly improved through effective inventory management [26]. When efficiency and accuracy are obtained, time can be saved. Moreover, time is money. On top of that, customers will not feel disappointed when the goods that they want will always be available.
Moving on, customers will have a better customer service experience. With the implementation of the cashless system, retail store owners and other staff members will not have to deal with the flow and movement of physical cash in and out of the store. This provides retail store owners the additional time to conduct beneficial activities such as employee management skills and service training to further enhance their skills. This in return will result in a better overall experience for any visiting customers. Furthermore, the current issue of using physical cash as a form of payment is that employees will be forced to work overtime to tally the accounts especially near the closing time of the store. This is because the employees are required to manually calculate the amount of cash in the drawer to ensure that the amount is equal to the receipts. This leads to employees neglecting their duties to serve the customer in order to finish counting the cash earlier.

Table 1. Benefits of this study to the customers.

| Benefits                        |
|---------------------------------|
| 1. Timesaving                   |
| 2. Safe and secure shopping experience. |
| 3. Well-merchandised store.    |
| 4. Better customer service experience. |

3.5 Benefits to the Retail Store Owners

One of the biggest benefits is maximizing sales profit. This is a major factor when it comes to ensuring a healthy sales growth rate of the store. With the application of the Customer’s Application and Smart Shelf, many of the frustration experienced by the customers can be eliminated. Nowadays, customers prefer to purchase their desired product without the need to queue long at a counter. The Customer’s Application eliminates the need to pay at the counter, thus allowing the customers to shop worry-free. Furthermore, customers who just had a positive shopping experience will eventually recommend the shop to their family and friends. This indirectly leads to free advertising for the store, thus further boosting the stores’ profits.

Besides, by implementing this project’s idea, especially the Smart Shelf, into their stores, the owners will have a better control on their inventory management. This leads to a better supply chain management and marketing strategy. A proper inventory management is crucial as it prevents owners from ordering excessive products [25][26]. This will prevent the need for owners to spend additional costs on storage space to store the excess products. Moreover, products with expiry dates, especially raw ingredients, will go bad and causes the business to lose a lot of money. These wastes can be avoided, and cash roll can be enhanced. A good inventory management may give the owners encouragement to further widen and expand their market to a higher level. In addition, an effective inventory management saves a lot of the retailers’ time [27]. Time saved can be used to attend to other relevant matters.

In this technological era, retail store owners who are always ready and willing to accept changes and adapt to the changes will have an edge over those who are still implementing traditional approaches. Therefore, by implementing this project’s idea, the retail store will have an upper hand. Not only because it can eliminate the need for a long queue and the need to use physical cash [23], but also of its uniqueness. Being a new concept, only a handful of stores are currently implementing technologies and AI into their businesses. Understanding AI can lead to many benefits that human can learn from [28]. A unique store will attract many new and curious customers to try it and it will be easy to amaze them. This is simply because the concept is still fresh, and many have yet to experience it.

Moving on, the implementation of this project will eliminate the need for additional labour costs. AI has somehow impact the labourers to an extent [29]. Owners do not need to spend additional costs on hiring cashiers as this role has been replaced by the Customer’s Application with its self-checkout system. Retail store owners will be able to use this additional cost to fund for other stffs such as giving bonuses and incentives to their employees to help boost their motivation and morale.
Table 2. Benefits of the project to the owners.

| Benefits                                      |
|-----------------------------------------------|
| 1    Maximizing profit.                       |
| 2    Better inventory management.             |
| 3    Upper hand against their competitors.    |
| 4    Eliminate the need for additional labour cost. |

3.6 Benefits and Contributions to University Students and Staff

The initial aim of this project is also successfully achieved. The most beneficial contribution of this project towards both the university students and staffs is definitely timesaving. In university, students are always busy with their assignments and studies, and are always in a hurry to attend their classes. This leaves them with a little time to buy food, snacks or drinks. The same can be implied to the staff as well. Here an example of a scenario. A student just finished attending a class and is now rushing to attend the next class. He or she has not eaten anything and is planning to buy a simple sandwich for lunch. However, the store selling sandwiches has a long queue. This will only leave the student with two mere choices. Either the student queue up and be late for the next class or skip lunch. Therefore, with the implementation of this project, both the Customer’s Application and Smart Shelf, the student will be able to easily grab a sandwich and perform an honest online transaction later through the Customer’s Application. The student will then be able to attend his or her classes on time without having the need to skip lunch. On top of that, security among the university students is enhanced with the implementation of face recognition system. Even students use their friend’s registered identity to pay, they could not unlock the shelf in the first place. Hence, they would not be able to purchase in the end. Based on other researches, the face detection is also used for large class attendance checking [30]. Therefore, the application of this technology is reliable in terms of security.

This concept can also be introduced to office buildings where working people are always busy and rushing for time. Whether dropping by for a quick breakfast or lunch, a convenience store implemented with this idea would be an advantage. Time management is a crucial factor for working adults and having such concept stores in their workplace is going to benefit them overall.

4. Conclusion

A combination of various modern technologies such as machine learning and IoT are needed to successfully develop a smart system which can be implemented into a retail store. Ultimately, the original aim and objectives of this project were successfully achieved. The system consisted of the Customer’s Application and the Smart Shelf. Integration of these two systems is the key that leads to the achievement of the aim and objectives of this research project. The concept and idea of this study enables a simple system to be developed and be beneficial to university students and staff. This system can be easily implemented at any corner of the campus to provide easy access to all the university students and staff. The main issue regarding long queueing time at the cashier is successfully eliminated with the help of a self-checkout system provided in the Customer’s Application. Also, the Customer’s Application eliminates the need for customers to use any form of physical cash such as paper money or even bank cards in order to purchase. A self-checkout system along with an inventory management system allows owners to eliminate the need for additional labour cost especially on cashiers and employees in-charged of managing stocks. With all these, once proper full scale of this system is properly built, overcoming the problems stated earlier would not be an issue.

The novelty of this project is the set-up cost. Cost is a major factor to be considered in every businesses and industries. The idea of our research project may overcome this. The concept may seem like an inferior method in terms of speed, precision, accuracy and security if compared to big players such as Walmart Intelligent Retail Lab and Amazon Just Walk Out Technology, however, the reality of it being a cheaper alternative that enables easy installation at any premises without much professional
support is vital. It gives smaller retail stores who does not have the capital or revenue as large as Amazon and Walmart the opportunity to experience first-hand the capability of AI in a retail store. In short, having an affordable smart retail system which can be easily setup in any situation is a crucial first step in influencing retail owners to embrace and adapt to digital transformation in order to achieve the establishment of a smart city.

There are a few recommendations and future works to be discussed. The core values of these project are strongly emphasized on its simplicity and cost efficiency yet impactful. Customers are still required to perform most of the task manually such as entering the number of products taken and its price and performing self-checkout which may be a hassle especially to those buying in bulk. Therefore, for future works, the self-checkout system can be upgraded to be a more autonomous similarly to the Amazon Go. Multiple cameras with machine vision would be needed in order to perform motion tracking and object detection. When a customer takes a product, the cameras would be able to detect the customers motion and the item taken. This would automatically send alert to the customer’s application on which items were taken and the quantity along with the price and automatically deduct money from either the bank card or an electronic wallet. Furthermore, ethical issues such as irresponsible placement of certain products into different shelves needs to be handled as well in the future. The addition of a weight sensor into the system would be able to help retailers to detect any misplacement of products in the shelves. Finally, with proper monetary funding, a proper full scale of this system could be properly setup to test the efficiency and functionality of this project.

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