

Implementation of Smart Mobile Point-of-Sale Cash Register System

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ABSTRACT. *The traditional fixed point of sale cash register is not only expensive and bulky, quite inconvenient in action. Although there are many shops to use mobile cash register, however, the cash register system is only written as a standard template, and then follows customer demand to implement a limited customized style of point of sale. Therefore, the goal of this research is to realize a live-trading mobile cash register that can handle multiple on-line transactions concurrently and is capable of intelligent back-end data processing and analysis for transactions, especially applying Web technology and back-end database for data exchange or third-party payment over Internet. Regarding Internet of Things, the wireless networking protocol Bluetooth is employed to connect with the front end devices together with its smart card related accessories where NFC technology is used to read data stored in smart card for connection and data exchange between smart card and the front end devices. This way makes a point of sale is not limited to be installed and fixed on the front desk, instead becoming a mobile cash register and proceeding online payment, providing consumers with convenience and fast transactions. Finally, conducting in-depth data exploration and intelligent analysis of data for use cases relevant to point of sale in the real world, it performs real-time key information acquisition for some of specific customer, providing enterprises with rapid and correct information and make it possible to work on the precision marketing.*

Keywords: Online Payment, Third-Party Service Platform, Intelligent Data Processing and Analysis, Internet of Things, Mobile Cash Register.

1. **Introduction.** This study aims to use relatively low cost to replace point-of-sale system that requires high cost in the market. Currently, point-of-sale system in the market is a complete set, which also contains a format system. System function also determines the sales price. Small stores or street vendors tend to carry inexpensive systems. Some

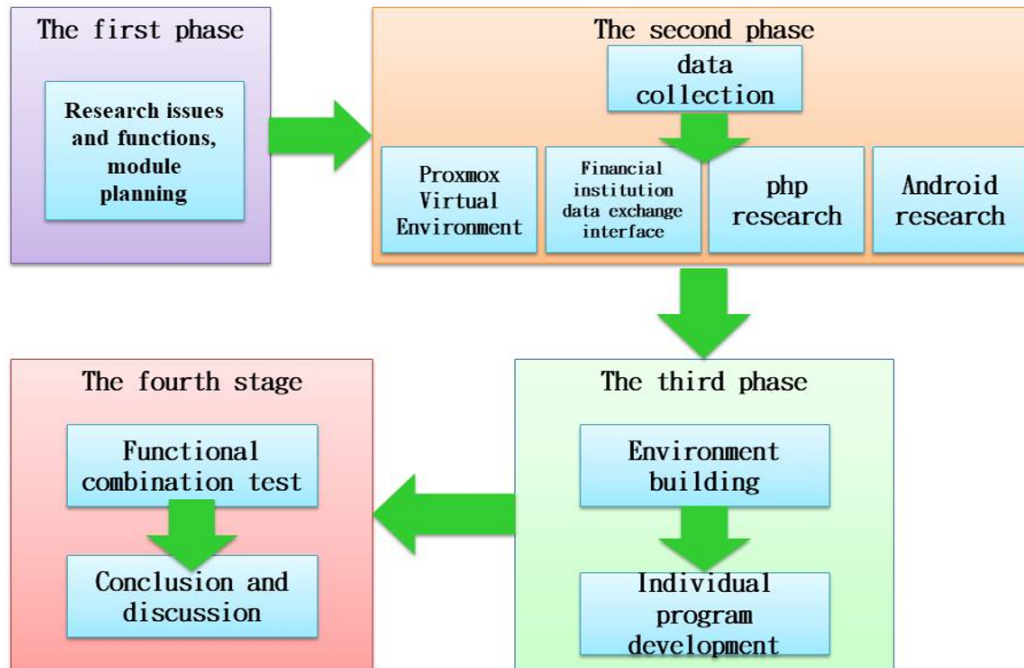


FIGURE 1. Research Process

systems that are well designed are rather expensive. The system developed by this study has a lower cost than most products in the market, by with more powerful functions and more supports and the research process has shown in Figure 1. The functions of the proposed system are designed according to the common operating modes, so it can meet the needs of general merchants. Each transaction process leads to numerous business opportunities, including information that can improve performance; thus, the big data should be analyzed to determine different models and demand of consumers.

The system proposed in this study includes three parts: (1) Android device (2) PHP Web Service (3) cash flow method. The development tool is Android Studio, and the programming language is Java. A large amount of information accessible on the Internet can be acquired and the updated technologies can be easily found on the Internet. The back-end server uses virtual host set up by Proxmox Virtual Environment [1] to execute Webservice, written using PHP, as the platform for the data exchange between the front and the back-end platform [2]. Finally, in terms of the cash flow method, money transactions can only be processed with data exchange specification published by various financial institutions. As the transaction involves the confidential security of financial institutions, the internal operation mode is not made public. Only the particular information exchange interface is made accessible to the public. Developers can simply communicate with it for cash flow. However, if the financial institution fails to provide communication interface of Android, it is impossible to be directly implemented in this study. If the communication interface of other programming language is provided, there are other ways to solve this problem.

2. Related Work.

2.1. Literature Review. As mentioned in Application of NFC Based on the Design of Mobile APP in Journal of Global Business Operation and Management, NFC near field communication technology in mobile phones can read and write Mifare Card made by RFID technology. i-Cash EasyCard launched under the cooperation with President Chain

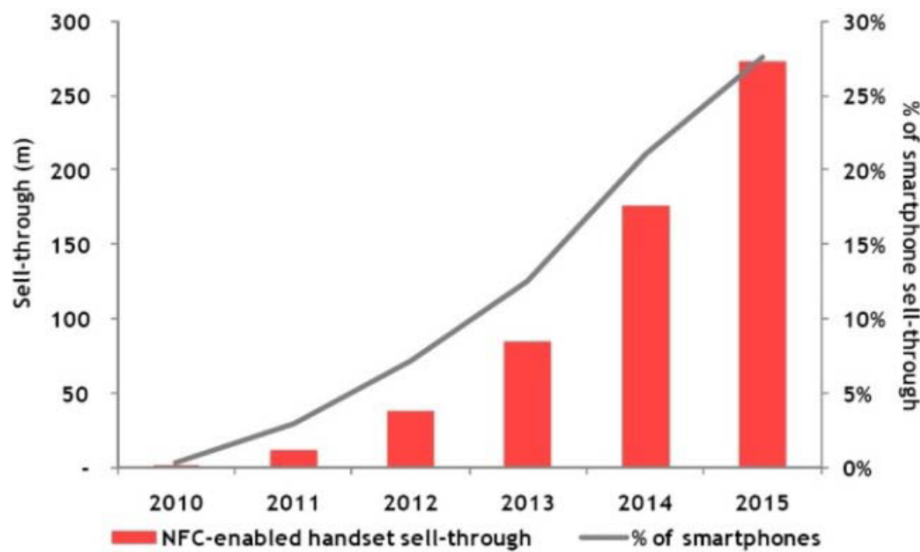


FIGURE 2. Predicted Growth of Mobile Phones

Store in 2009 was made with the card of such specifications [3][4]. If it can be combined with merchant's mobile cash register system, it can greatly improve operating efficiency and also attract the consumers used to this card for consumption, plus Mifare membership card developed by merchants themselves, which records the membership points obtained from the consumption. Statistics have shown that mobile phones with NFC functions would increase by 30% after 2015. Hence, NFC technology is an essential technology in smart phones. The growth trend is shown in Figure 2. Bluetooth communication technology is used in this study to connect to thermal printer. Bluetooth communication is one of near field communications. As Bluetooth uses peer-to-peer online mode, the setting is simple, and the transmission speed is fast. The online distance is at least 10 m. It is very convenient to use, and the transmission of text and data is rapid and robust [5]. It is thus a good choice to use when transmitting and printing documents and other information. Figure 3 shows the comparison between the advantages and disadvantages of transmission rate between Bluetooth and NFC. When the transmission capacity is less than 4KB, NFC speed is faster; when the transmission capacity is over 4KB, Bluetooth speed is much faster. Although the capacity of printed text is small, transmission speed slows down significantly if the transaction data increases. In terms of barcode identification, Reference [6] mentioned that barcode has been widely used in the market, and the use of barcode for identification has become popular. CCD sensor is used to receive the reflected image data as the basic image for identification. HTTP data exchange framework is used in Reference [7], the back-end server host uses the architecture of Apache. Regardless of the types of systems, small database is needed to record the related data for different uses. In Reference [8], SQLite database provided by Android is used to store the user's chat records in the design and implementation of online instant messaging software on the Android platform. Application software belonging to OSI model Layer 7 includes web browser (Internet explorer, Firefox), for example, the illustrated pages can be presented through the communication of web browser via HTTP [9]. Near field communication is a kind of high frequency wireless technology in a short distance, and it runs within the distance of 20cm at the frequency of 13.56 MHz [10]. Its transmission speed has three kinds of 106 Kbit/sec, 212 Kbit/sec and 424 Kbit/sec. NFC uses active and passive reading patterns [11] [12]. MIFARE is the registered trademark of NXP Semiconductors

Diagram for Comparison of Actual Transmission Time between NFC P2P and Bluetooth

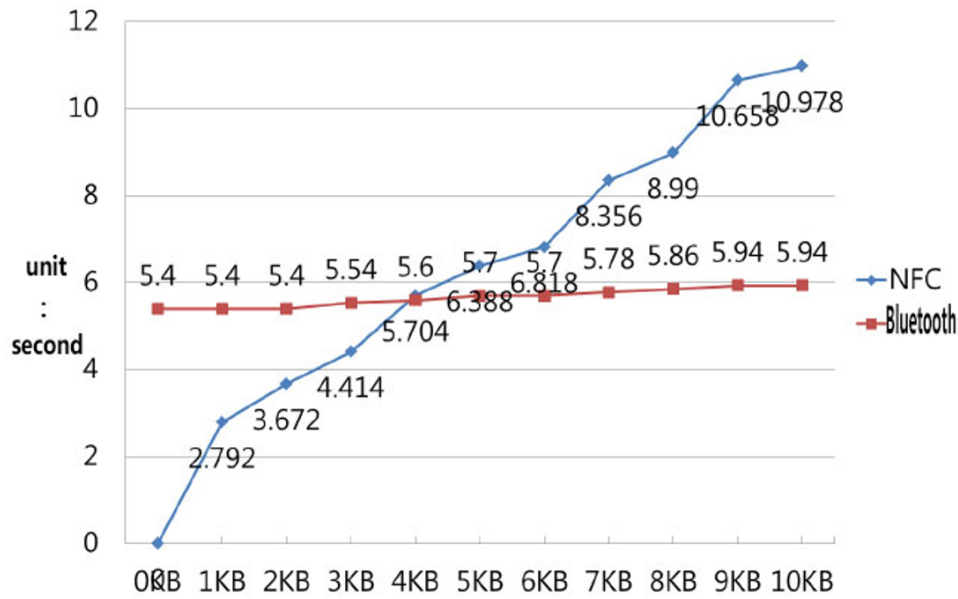


FIGURE 3. Diagram for Comparison of Actual Transmission Time between NFC P2P and Bluetooth

Diagram for Data Storage Block

Sector	Block 0	Block 1	Block 2	Block 3
0	data storage area	data	data	Key 、 Access bit
1	data storage area	data	data	Key 、 Access bit
2	data storage area	data	data	Key 、 Access bit
:	:	:	:	:
14	data storage area	data	data	Key 、 Access bit
15	data storage area	data	data	Key 、 Access bit

FIGURE 4. Diagram for Data Storage Block

in the field of contactless smart card and near field induction card. MIFARE is contactless smart card established according to ISO/IEC 14443-A specification, which uses wireless radio frequency identification (frequency of 13.56 MHz) to complete the verification. Data storage block of Mifare card is as shown in Figure 4. Triple verification steps of MIFARE card machine has been done, if it is correct will do something like deduct money, open the door or register other items [13] [14]. QRcode application scopes have been expanded to product tracking, item identification, file management and marketing. [15]. Bluetooth, a kind of wireless technology standard, can connect multiple devices and overcome the problem of synchronization [16]. The transmission protocols of Bluetooth are collected as shown in Figure 5 [17].

3. System Implementation.

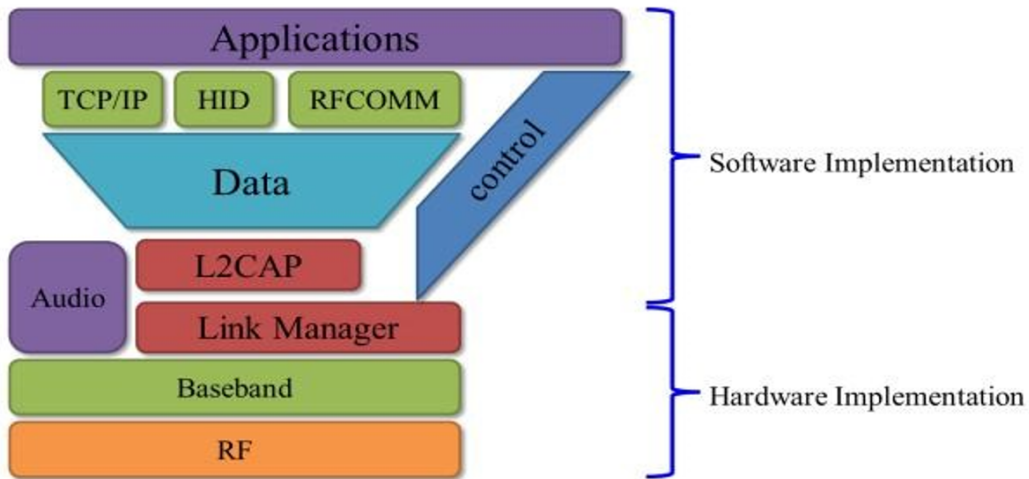


FIGURE 5. Schematic Diagram for Bluetooth Transmission Protocol

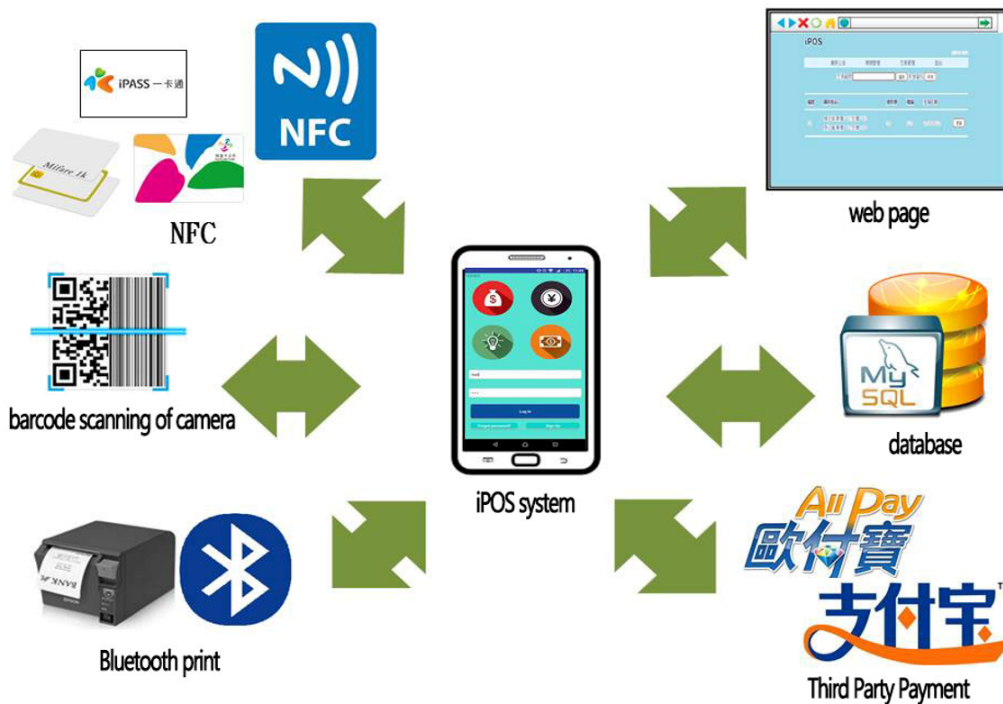


FIGURE 6. Complete Architecture Diagram

3.1. **Architecture Diagram for Main System.** First of all, start point-to-sale system APP installed in the mobile phone, the system begins to run after logging in the system, the sales system mainly has three functions, (1) statistics and record of trading items and sales amount (2) data exchange through the Http communication protocol, including the uploading of communication mode of transaction data and cash flow (3) control of peripheral hardware of smart phones, such as Bluetooth print, reading and writing of Mifare induction card and barcode scanning of camera, the overall architecture is as shown in Figure 6.

3.2. **Introduction to Development Tool.** This program makes Android Studio 2.0 as the Development Tool, such tool is launched newly by Google, formal version 1.0 was

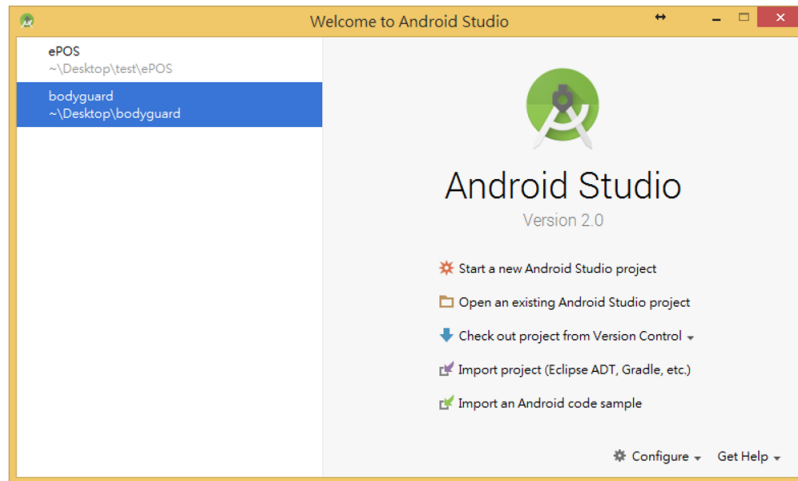


FIGURE 7. Home Screen of Android Studio

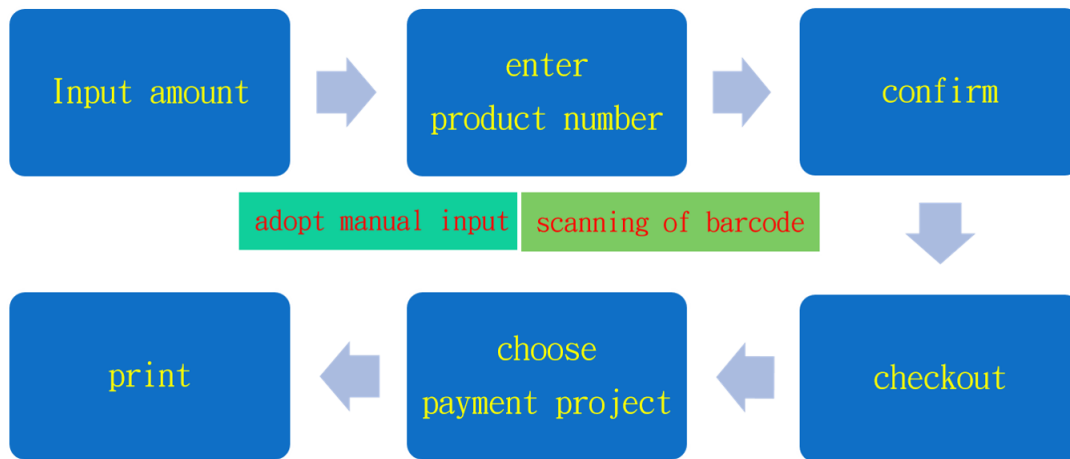


FIGURE 8. Transaction Process Diagram

promoted in December, 2014 for free download and use to everybody, and the following is the simple teaching for setting of installation environment:

- (1) Install JDK, it must be installed as the main language of Android is Java. Oracle Java JDK Download location is as follows: <http://www.oracle.com/technetwork/java/javase/downloads>
- (2) Download and install Android Studio Tools
- (3) Home screen will appear to make users choose to start a new project or import an old project after the first execution. Screenshot at [18] [19] is shown in Figure 7.
- (4) Open Android Studio to download Android SDK Tools. and other relevant information.
- (5) Please refer to [18] for detailed installation steps.

4. System Operation.

4.1. Transaction Process. Input amount first, then enter product number, press enter key, then press checkout button to choose payment project, and then press print button after the end of input. Among them, the input of product number can both adopt manual input mode or scanning of barcode. Its process is shown in Figure 8.

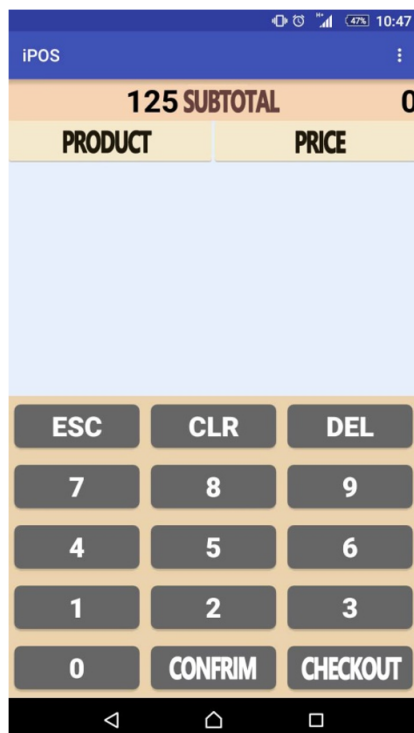


FIGURE 9. Manual Input of Amount

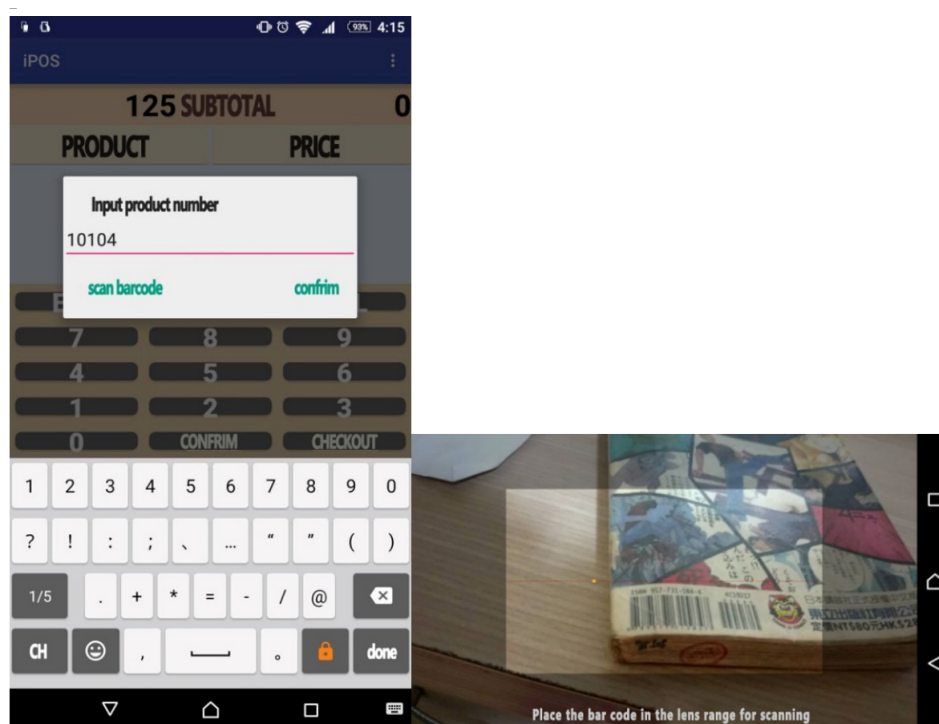


FIGURE 10. Manual Input of Product Number or Scanning of Barcode

The system picture of each function is shown in Figure 9, the picture of manual input of amount Input product number or scan barcode:

Product Deletion Function Input: press such product for a long time for the deletion.

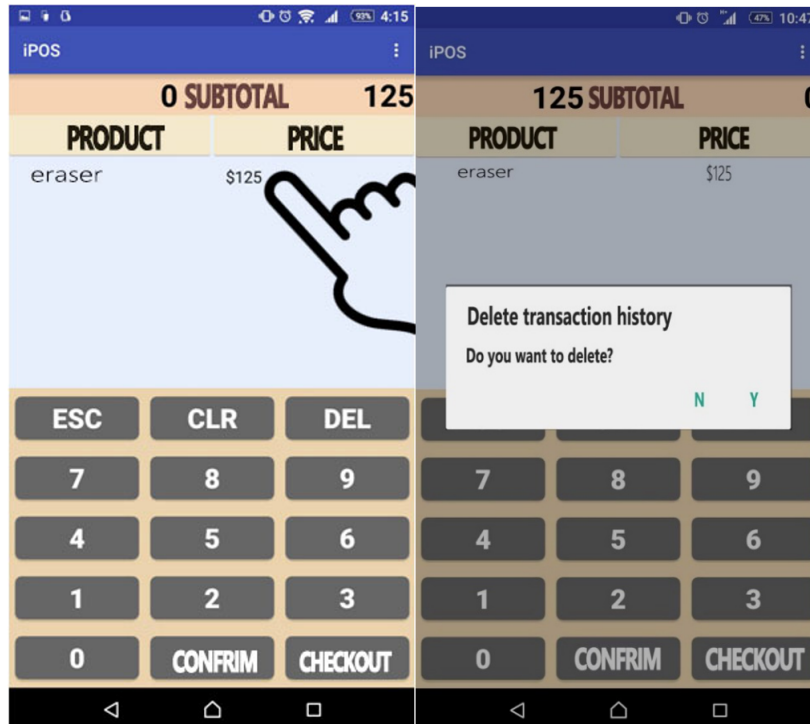


FIGURE 11. Product Deletion Function

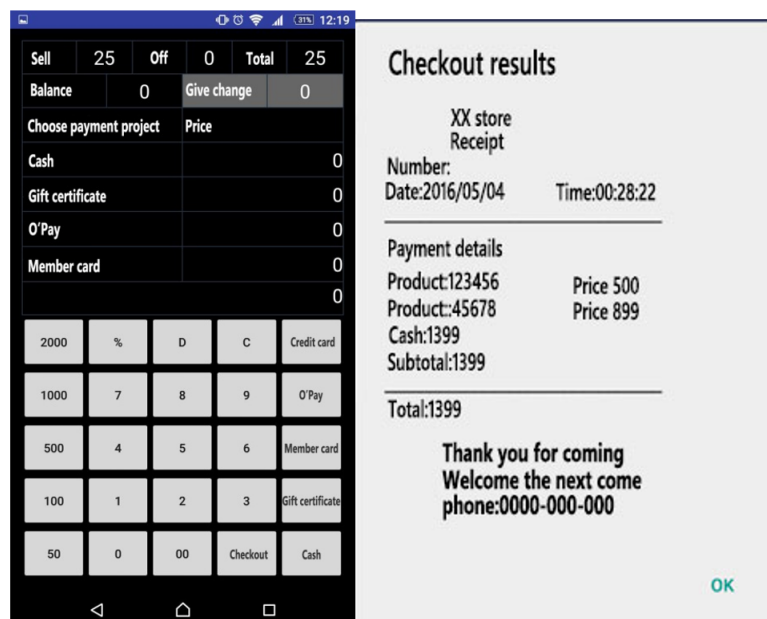


FIGURE 12. Checkout Function

Checkout Function: Press checkout button to choose payment type, and then press checkout number to print the receipt.

Introduction to multiple functional menu selection: there are selection items to set sales system or the functions of newly added products and sales return. Sales Return Function: Sales return is divided into the whole return or partial return, the whole return means bringing the purchased products, receipt and electronic invoice to input the transaction number, delete the sales records and return the payment to the consumers. In case of

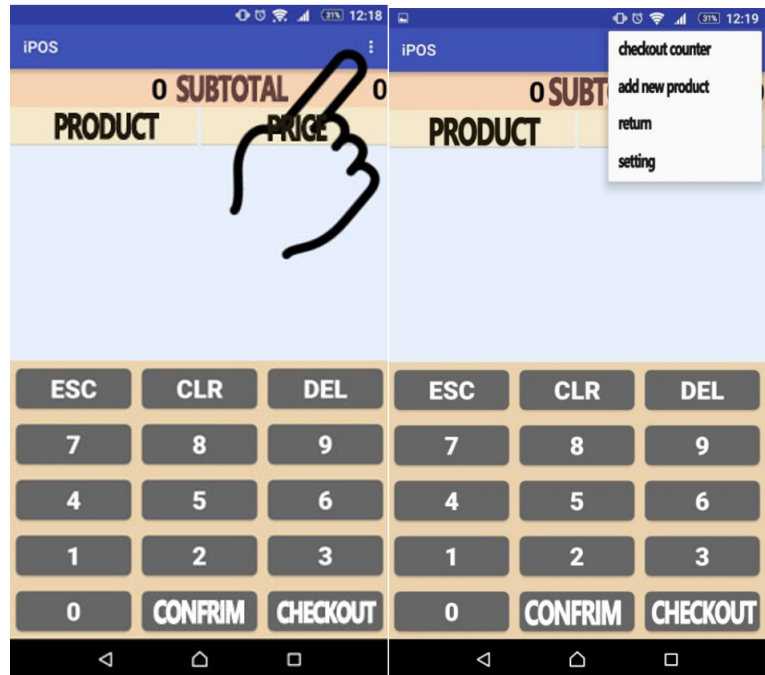


FIGURE 13. Multiple Functional Menu Selection

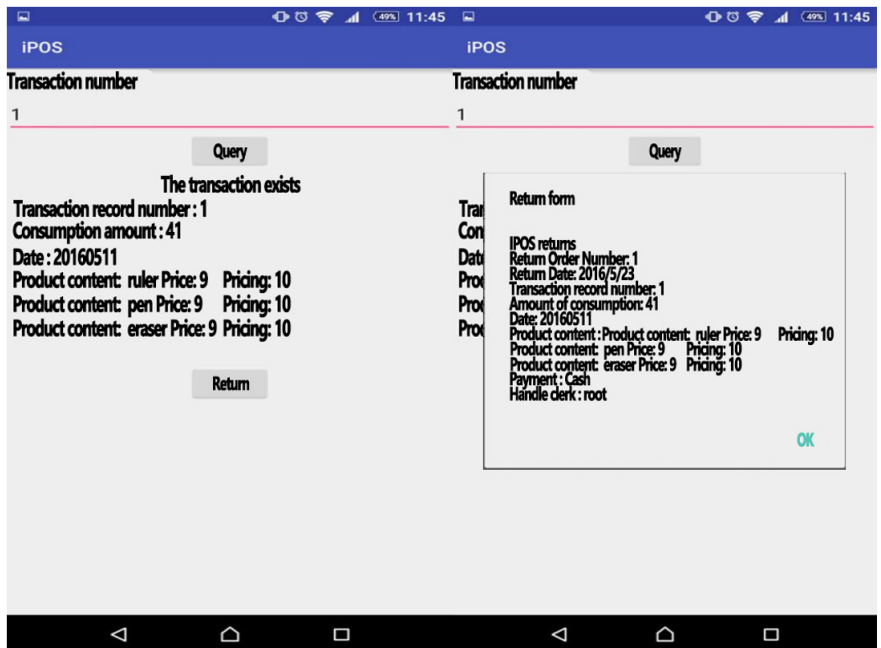


FIGURE 14. Sales Return Function. Backstage Management System

partial returning, it needs to return all of the payment first and then input the price of products desired into a new sales record and then the amounts returned to consumers are recalculated.

Login Page: input account No. and password to enter backstage management system.

Account Management: adding, deletion and modification are allowed in the account management of sales system here, and staff can use it as log ID.

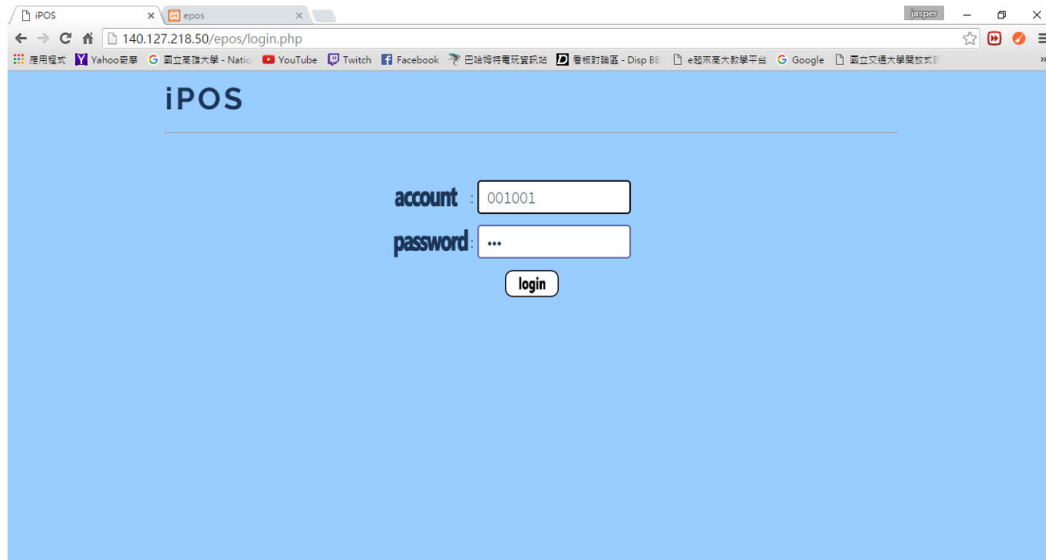


FIGURE 15. Login Page

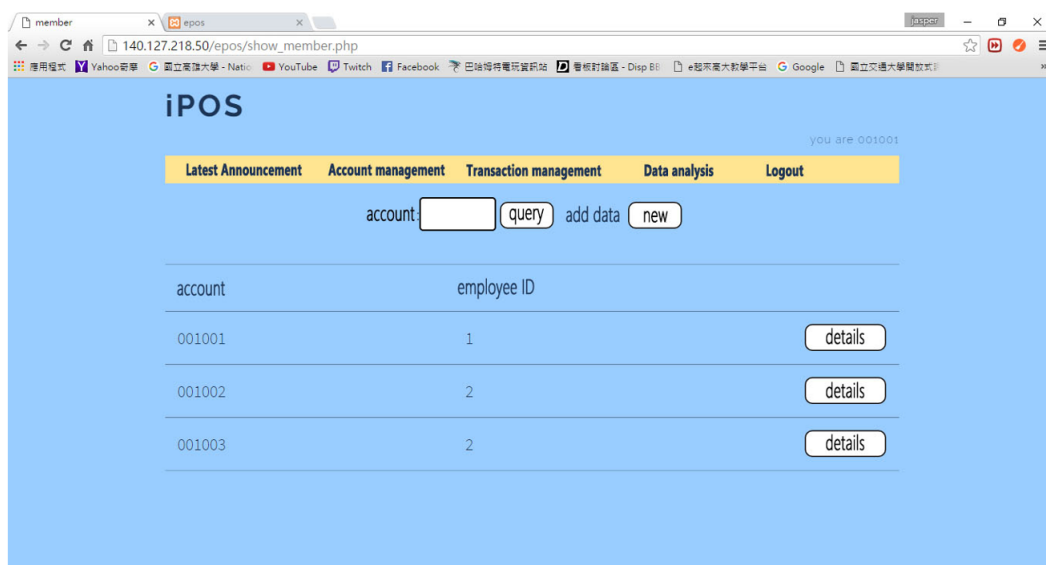


FIGURE 16. Account Management Page

Transaction history record and management page: we can see every transaction history record and amount here and the detailed product projects purchased after clicking on the Detailed Record.

Detailed Product Project: Click on Detailed Record to see purchased detailed product project.

4.2. Implementation of Payment System of All Pay. Use data transmission interface (PHP API) provided by All Pay to generate two-dimensional barcode on the web page of mobile sales system, make consumers to scan the code and lead them to the payment page of All Pay, where customers can choose the payment mode they want, such as credit card, online ATM, account of All Pay and so on. The cash flow process of credit card is shown in Figure 19.

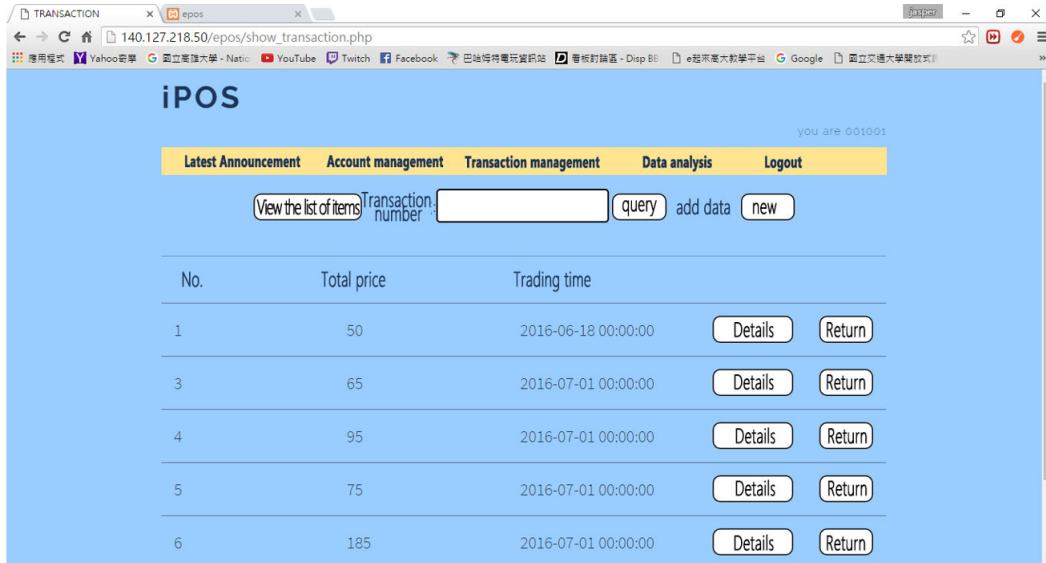


FIGURE 17. Transaction History Record and Management Page

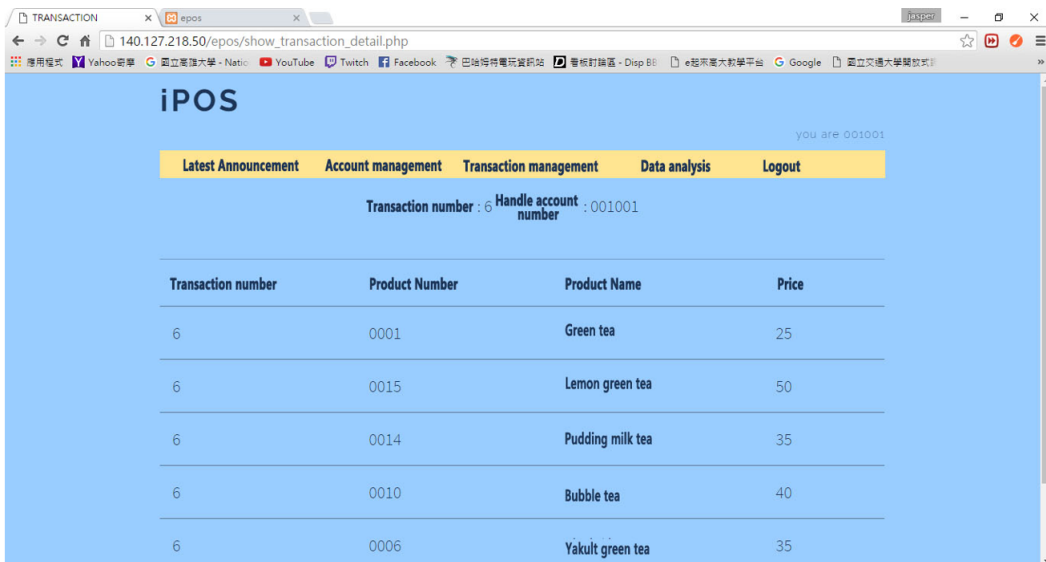


FIGURE 18. Detailed Product Project Page

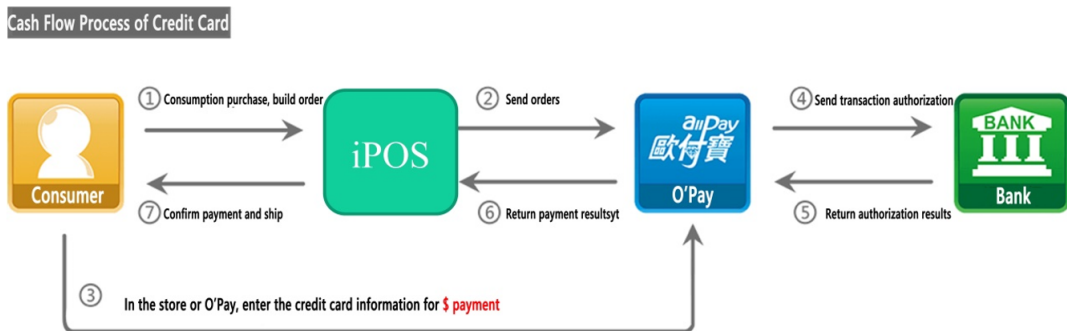


FIGURE 19. Cash Flow Process of Credit Card

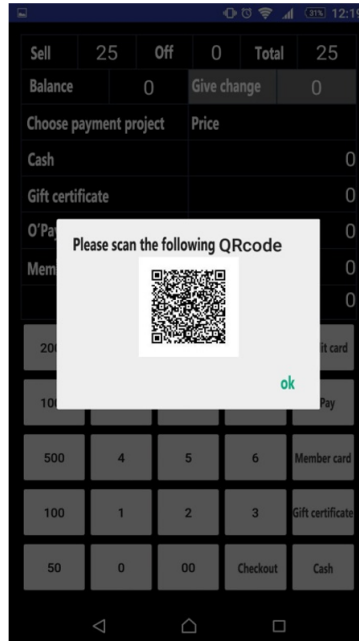


FIGURE 20. Two-dimensional Barcode Generated by Sales System

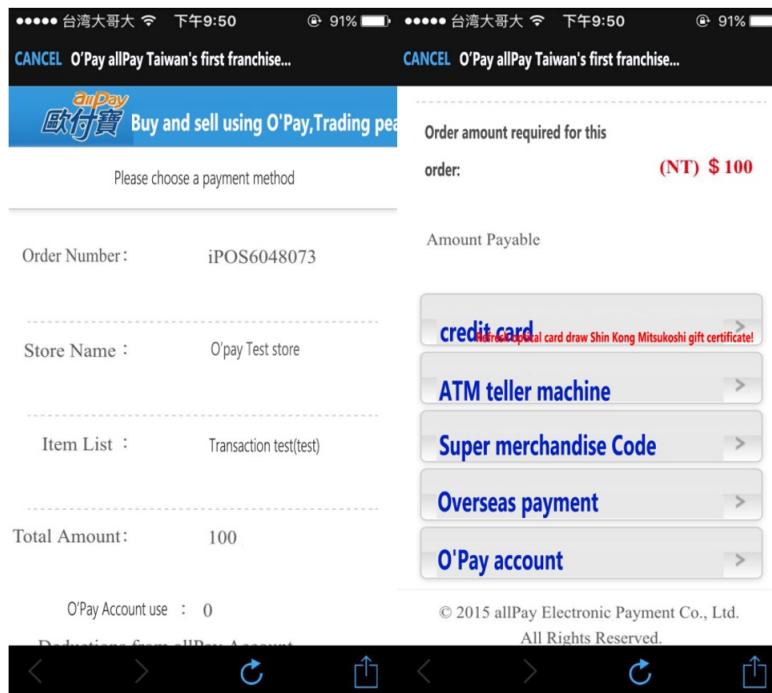


FIGURE 21. Picture of Consumers Entering AllPay Payment

The picture for two-dimensional barcode picture generated by sales system is as follows:

The picture of consumers entering payment of All Pay is as follows:

Picture of using credit card payment: input relevant information and complete identification verification to finish the payment.

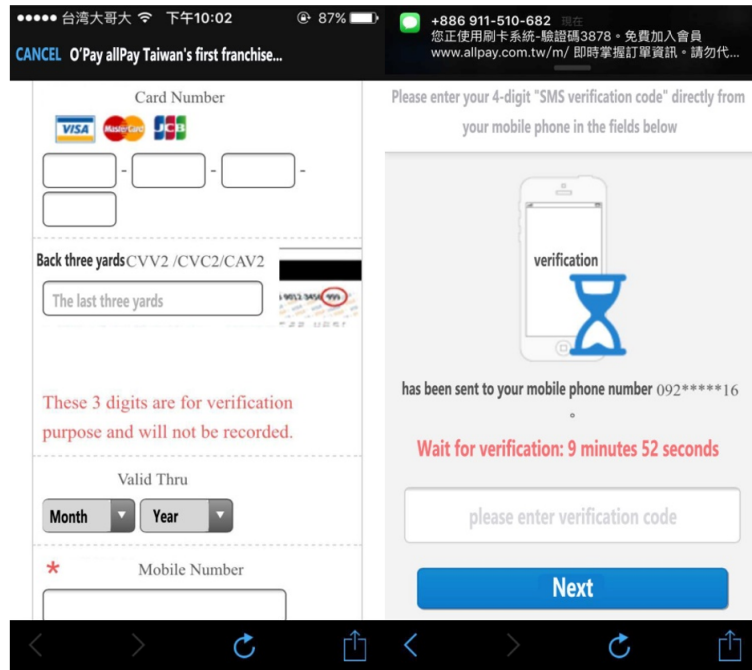


FIGURE 22. Picture of Credit Card Input and Page of Identification Verification

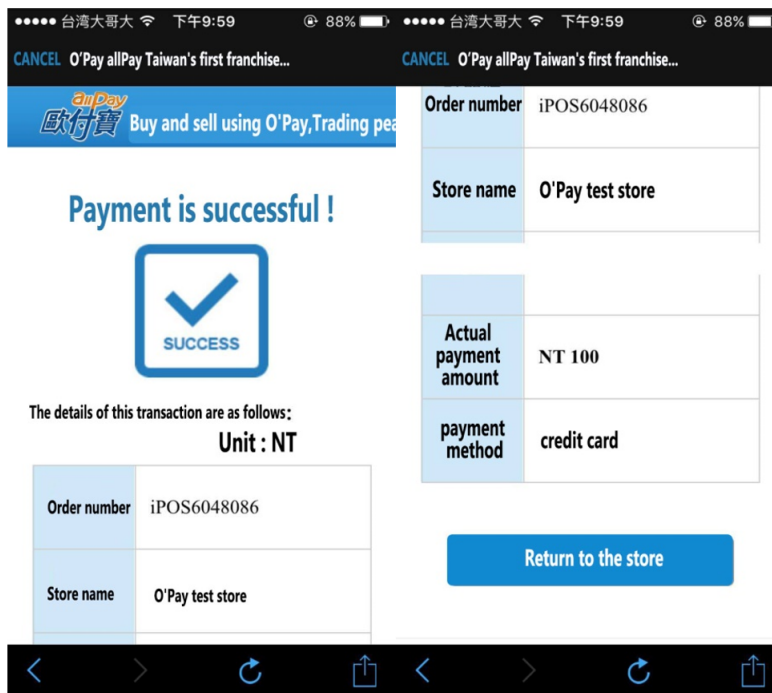


FIGURE 23. Picture of Completing Transaction

The picture of completing transaction is shown in Figure: sales system can search that the payment of this order has been completed, and checkout can be done and the product can be given to consumers.

Electronic purse issued by merchants themselves: it can make consumers store money first, then write the amount into card and background database, and consumers can enjoy

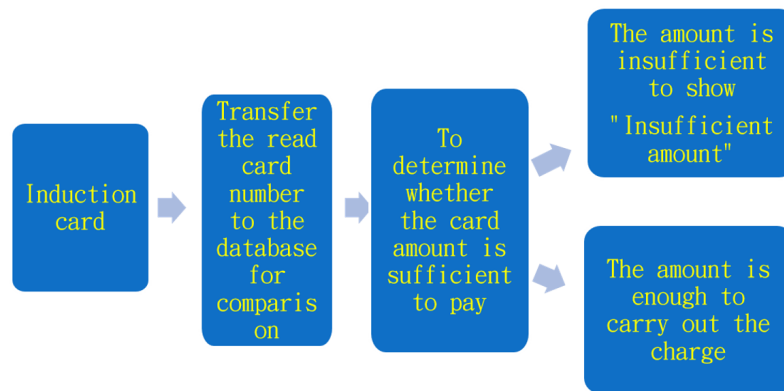


FIGURE 24. Payment Process Diagram for Electronic Purse

discounts in case of the consumption with this card. The payment process of electronic purse is as shown in Figure 24.

5. Case Study.

5.1. Data Collection. In order to exploit the value of the back-end database system, it will conduct in-depth data exploration and analysis and then goes to the decision-making. The system starts with the use of data processing and analysis capabilities and flexible allocation of computing resources, proceeds business analysis of real-time cash register related target customers (existing customers and potential customers), and thereafter provides enterprises with rapid and correct information to do decision-making.

TABLE 1. Main Merchandises at Name Brand Counters in Department Store

	LOUIS VUITTON	SKII	Supreme	Tiffany & Co	Chanel	Under Armour
1	Baolong luxury business card holder	Youth miracle spray essence	agnesb Isctan limited irony	Heart Pendant 925 sterling silver enamel necklace	ALLURE HOMME SPORT perfume	Ms. UA Ignite VII Slides
2	Classic LOGO embossed scratch scratch leather buttoned credit card sets	Ultra-light protection group	Day little white / black / gray at the end sport.b water blue / dinosaur / bronzing	Heart Pendant 925 Sterling Silver Pink Enamel Necklace	ALLURE Women Perfume	Men's UA Spotlight Turf soccer shoes
3	S patent leather embossed credit card business card holder	Super muscle can be smooth and flawless	Yarn Weaving Towel Set	Elsa Peretti 12mm Water Drop Sterling Silver Necklace	N° 5 light fragrance	Men's UA Lockdown 2 basketball shoes
4	Water ripple leather six buckle key case	Super muscle due to drilling light powder condensate cream group	Printing hit dinosaurs	Love letter engraved charm key necklace	CHANCE Orange Light Dance Eau de Toilette	Boy UA X Level Destroyer running shoes
5	Calfskin embossed card	Super muscle due to net spot discount group	Camouflage red casual short	Lettering Key Chain 925 Sterling Silver Double Chain Bracelet	Pink sweet female Eau de Toilette	Lady UA Charged Bandit 3 running shoes
6	Water ripple leather credit card zippered wallet	Youth Repair Essential Oil	Erase BOX LOGO round neck cotton short	Return to Tiffany Heart Pendant in 925 Sterling Silver	CHANCE encounter female light fragrance	Ms. UA SpeedForm AMP 2.0 training shoes
7	New checkerboard plaid claw button long clip	Super muscle can cream cream group	Orange word camouflage leisure short	Smile Smile Classic Rose Gold Necklace Crystal Pen Holder	Modern COCO (white) light fragrance	Men's UA SpeedForm AMP 2.0 Training Shoes
8	Original flower JOSEPHINE long clip	R.N.A. Supercoma can be tight stretch essence	WOLF simple cotton short	Classic LUCIDA Series 18K Gold 3mm Wide Edition Wedding Ring (# 4)	N° 5 L'EAU Fresh morning dew fragrance	Ms. UA SpeedForm Velociti Graphic running shoes
9	Series of classic Damier Azur canvas zipper long clip	Youth compact gift box	2013 HOOD BY AIR x X light spine HBA double zipper	T series 18K gold T LOGO modeling narrow version of the coil bracelet (m)	Black COCO perfume	Men's UA SpeedForm Velociti Graphic
10	Water ripple leather zipper long clip	Youth light sense of white discount group	Autumn and winter new off white shark hooded jacket	Keys petal key really drilled 18 white K decorated (silver)	Allure charm of the male fragrance	Men's UA Curry 3 Low Basketball Shoes

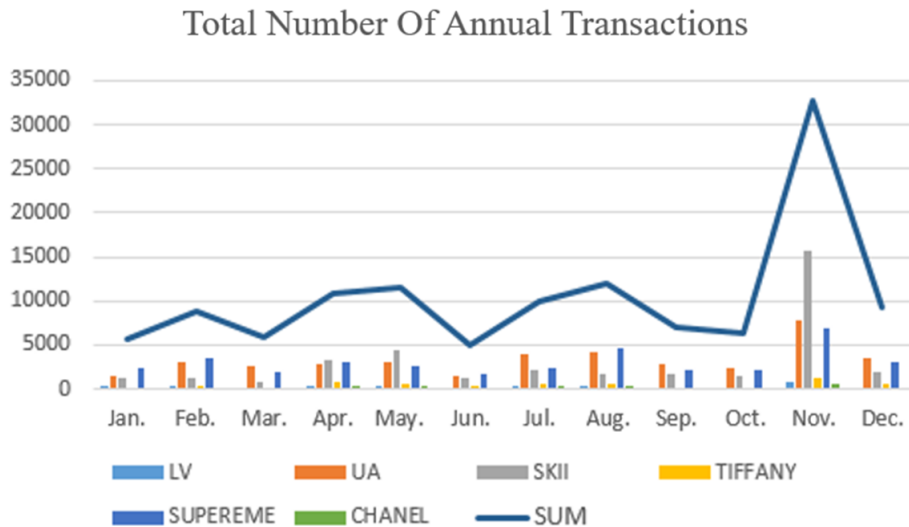


FIGURE 25. Annual Transactions for Each Counter and Overall

Therefore, the empirical analysis of a real use case will give an example of a large department store in Kaohsiung city located southern Taiwan. The back-end database has collected the revenue data of six name brand counters at a department store such as LOUIS VUITTON, TIFFANY, Supreme, SKII, CHANEL, UNDER ARMOR in 2016. The back-end database has selected data on top 10 best sales of goods from each name brand counter as shown in Table 1, and has the total of 3125020 transaction records collected for statistical analysis.

5.2. Big Data Analytics. The results of big data analysis show that the transaction frequency and turnover has greatly increased on such name brand counters as Tiffany, SK and CHANEL in Mother's Day festival. In Fathers Day festival, the transaction frequency and turnover on such name brand counter like UNDER ARMOR has risen significantly. In additions, the explosion of transaction frequency and turnover of each name brand counter is apparently during annual sales in November every year. According to its statistical results, each name brand counter for different running promotion is able to do the corresponding promotional activities and manpower scheduling. For example, in Mothers Day festival, the best sales have been promoted like cosmetics, perfume and name brand bag by receiving one hundred rebate for every thousand purchase, while the average turnover of the name brand counter has decreased dramatically in June and it try to reduce human spending so as to enhance the overall turnover, the statistical results shown in Figures 25 and 26.

5.3. Smart Decision-Making. In order to strengthen the future sales of various merchandise, the use of the characteristics of the data to do the correlation analysis and time series analysis, the purpose is to discover the relationship and frequency of the preferences of the brand for men and women in Kaohsiung region and the name brand merchandise purchased during a period of time. Afterward it also increases the hit rate of merchandise sales, with the capability through a series of current data to predict the possible value of unknown data in the future. In the basis of customer transaction records from 2015 and 2016, it can analyze the preferences of name brand merchandise in various regions in Kaohsiung city and the results of the analysis have shown in Figure 27. According to the statistical results, we found that in the following Kaohsiung administrative distracts, Lingya, Cianjin, Zuoying, Sanmin, and Cianjhen, were much more consuming capacity

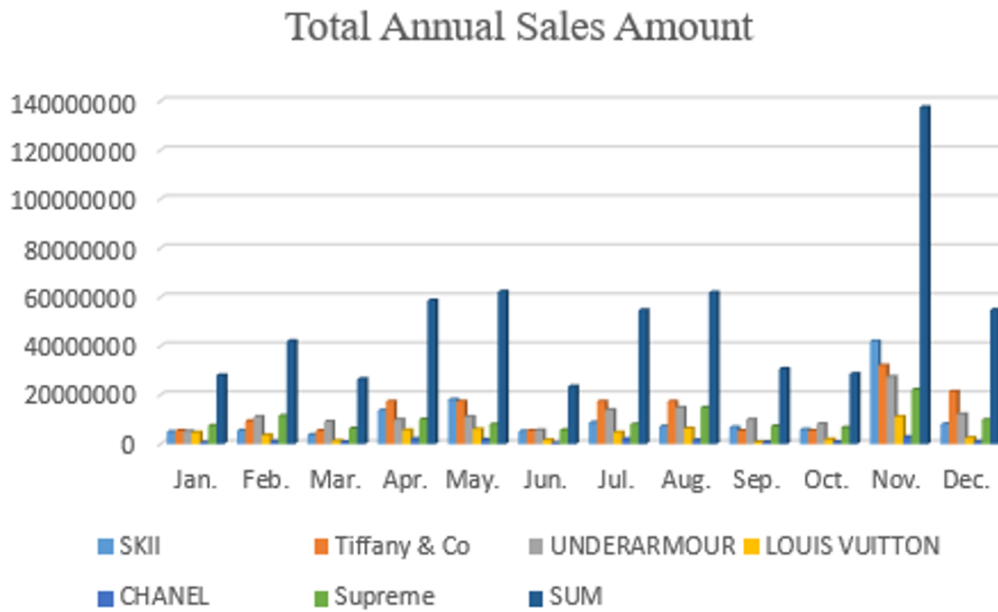


FIGURE 26. Annual Turnover for for Each Counter and Overall

than any other districts. Moreover, in Figures 28 and 29 the time series analysis of consumer behavior was taken for the men and women who are resident in those five districts purchased at the name brand counters in the department store from 2015 to 2016. Based on the analysis methods and results mentioned above, we can focus on the precision marketing on different merchandise for men and women in different districts. For example, in Sanmin district, we strengthen the consumer advertising notice for UNDER ARMOR mens shoes, buy one, get one 60% off, promotional activities at the department store, and the obtained benefit in this district will be higher than in Zuoying distract because the per capita consumption quota of UNDER ARMOR in Sanmin distract is higher than other regions, and the most of purchases have done by men. Lingya distract is yet the best focus for marketing target as promotional activities on cosmetics and popular boutique at name brand counter like SK , LOUIS VUITTON. In short, start with the smart analysis of sales information and then go for the precision marketing that will get your business to achieve the highest yield.

6. Conclusions. As a matter of fact, mobile cash register is not able to print an electronic invoice at present, because it must get the permission from the Ministry of Finance at the beginning so as to allow to print an electronic invoice. There is feasible to print an electronic invoice by means of opening a personal store and its annual turnover reaches a certain threshold. Hardware peripheral that can support mobile phones is currently not comprehensive. Although there are magnetic stripe card readers for mobile phones, their security can't be identified by banking institutions. If you really want to achieve cash flow directly with banks, you still have to wait for banking institutions to release the way of communication or related hardware devices, otherwise it is unable to conduct transactions directly with banks at present. The issues mentioned above are the main directions for future work to make POS system become more completeness, closer to the function of traditional POS, and more convenient in the use. When hardware peripheral and its functions are getting better and better, and security mechanism become more robustness, it is able to replace traditional POS system completely, which can not only greatly reduce the cost, but also bring the convenience in the use as the size of devices is minimized to

Month of Sales in Each Kaohsiung Administrative Region

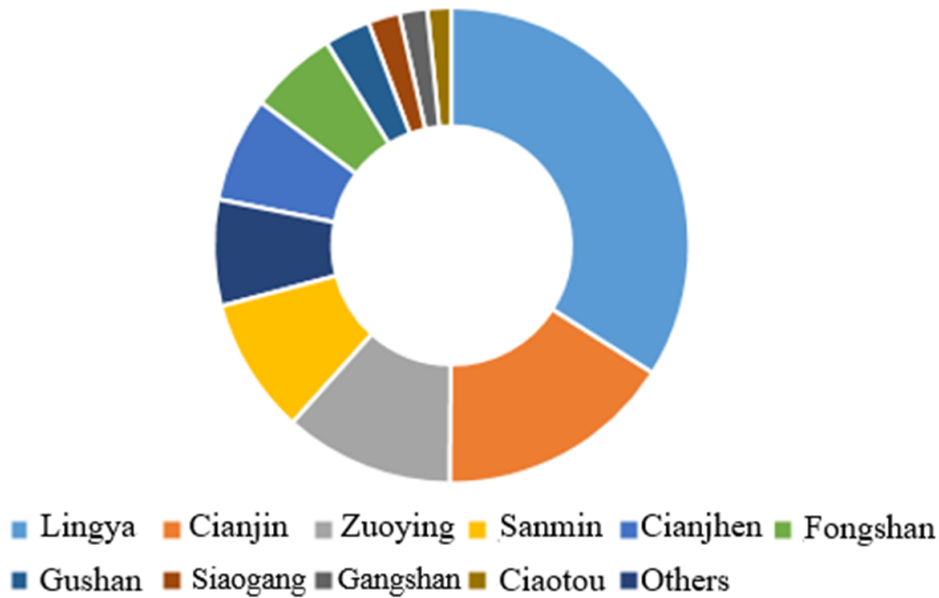


FIGURE 27. Month of Sale for Each District in Kaohsiung

Total Annual Sales in Each Kaohsiung Administrative Region

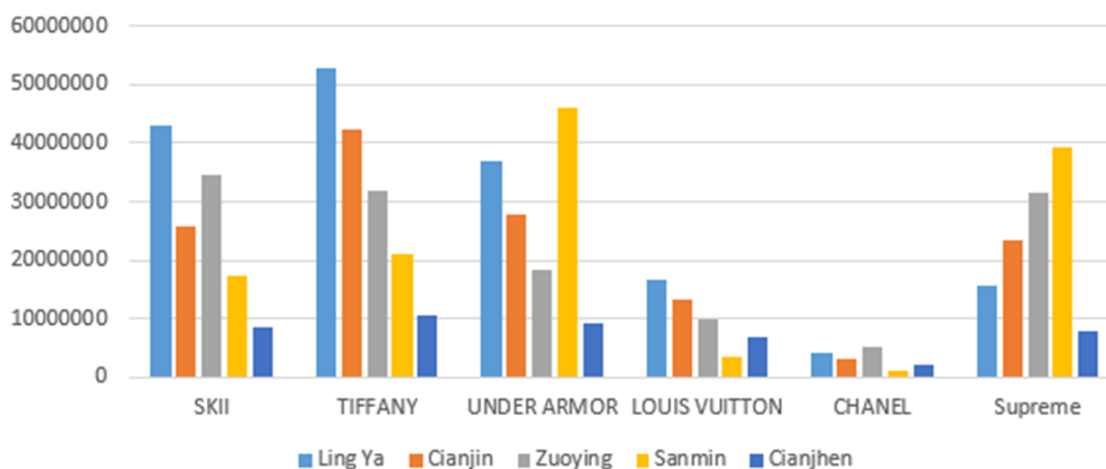


FIGURE 28. Top five of Annual Sales for Counters and Districts in Kaohsiung

a small one. Even more adding the concept of warehouse management and integrated with the result of data analysis in the future, you are able to learn about what are short of products or materials at this moment only by pressing a few buttons, so as to save storage space and predict future trends to help enterprises make decisions. Furthermore, it could be linked with the supplier or logistics and can directly to place orders, which not only speeds up the purchasing and saves personnel costs, but enhances the operating efficiency. Finally, conducting in-depth data exploration and intelligent analysis of data for use cases relevant to point of sale in the real world, it performs real-time key information acquisition for some of specific customer, providing not only enterprises with rapid and correct information and make it possible to work on the precision marketing, but also as a short, medium-term operation of the business strategy.

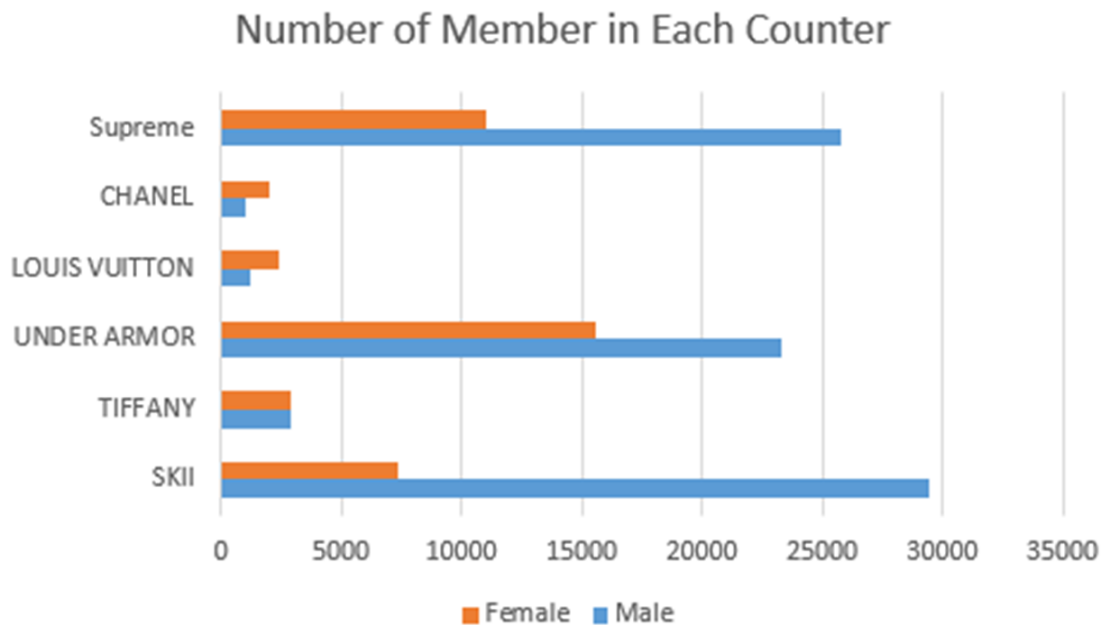


FIGURE 29. Number of Transactions at Each Counter with Gender Count

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