Journal of Advanced Technology Convergence
Vol. 03. No. 02 pp. 09-15, 2024
ISSN 2951-2468 (Online)
DOI : https://doi.org/10.23152/JATC.2024.03.02.009

A Study on the Efficiency of Cafeteria Management Systems

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구내식당 관리 시스템의 효율성에 관한 연구

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Abstract Due to the high inflation rate of dining out, along with changes in group meals or cafeteria services, office workers are increasingly using workplace cafeterias to reduce their meal expenses even slightly. With the recent development of ICT technology, various fields are realizing that not only are smartphones becoming more popular, but they are also becoming an integration of the latest technologies. In this paper, we analyze the current status of cafeterias with a large number of customers and propose ways to improve problems or difficulties. Since most people always carry their smartphones for urgent communication or work tasks, we aim to develop a cafeteria management system that utilizes the NFC function of smartphones. By presenting the process from customer entry to menu selection, it will enable more efficient use of the cafeteria.

Key Words : Cafeteria, ICT, Smartphone, NFC, Customer authentication

요 약 단체급식 또는 구내식당의 변화와 더불어 높은 외식 물가상승률로 인해 직장인들은 조금이라도 식사비용을 줄이기 위해 구내식당을 이용하는 횟수가 증가하고 있다. 최근의 ICT 기술발전으로 스마트폰의 대중화 뿐만 아니라 스마트폰은 최신기술들의 집약체가 되고 있음을 다양한 분야에서 실감하고 있다. 본 연구에서는 이용하는 고객수가 많은 구내식당의 현황을 분석하여 문제점 또는 애로사항을 개선하기 위한 방안을 제시한다. 긴급연락이나 업무처리를 위해 대부분의 사람들이 스마트폰을 항상 휴대하고 있으므로, 스마트폰의 NFC 기능을 이용하는 구내식당 관리시스템을 개발하고자, 고객입장부터 메뉴선택까지의 과정을 제시하여, 보다 효율적으로 식당 이용이 가능할 수 있다.

주제어 : 구내식당, ICT, 스마트폰, NFC, 고객인증

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Received May 27, 2024 Revised June 7, 2024
Accepted June 21, 2024 Published June 30, 2024

1. Introduction

In March 2024, the overall domestic inflation rate was 3.1%, and the restaurant inflation rate was 3.4%. Many changes have also occurred in the group meal service market, which had collapsed due to the COVID-19 pandemic over the past three years. Due to the policy of minimizing group gatherings and face-to-face work to prevent the spread of coronavirus, the number of individual meals in separate settings has increased rather than group meals. However, with the transition to endemic status this year and the continued high inflation rate, the number of people using workplace cafeterias has increased significantly. Looking at the changes in workplace cafeterias that provide group meals over the decades, in the 1980s and 1990s, Korean meals typically consisted of one soup and three or four side dishes. In the 2000s, the shape of the plate also changed as the menu became more diverse, including Jjajjang rice, hamburger, and steak. In the 2010s, food court or buffet-style cafeterias became popular, especially in the IT industry with many young office workers. In the 2020s, with the increasing emphasis on health, there has been a rise in demand for low-calorie and low-sugar meals that do not exceed standard calorie counts, as well as a significant increase in the demand for lunch boxes due to the COVID-19 pandemic[1]. In addition to these changes in group meals or cafeterias, as mentioned earlier, the number of customers using cafeterias is increasing due to the high inflation rate of dining out. However, with the increase in cafeteria users, institutions operating workplace cafeterias are also implementing measures such as increasing the number of closed days or reducing the usage of cafeteria services to support nearby restaurants that have seen a decrease in customers due to the long-term economic downturn and the COVID-19 crisis[2].

As we looked at the changes in group meals earlier, the atmosphere and scenery of cafeterias are changing rapidly recently. Due to the nature of group meals, the same menu is repeated every day, and in addition to regular Korean food called Baekban, the menu has become more diverse, including snack foods, lunch box style, Western food, and bakery items. This is changing the cafeteria as the expectations of MZ generation employees regarding company welfare are improving along with the spread of non-face-to-face culture. To this end, cafeteria operators are exploring various ideas to meet the needs of users and are introducing systematic management plans for cafeteria operation.

With the recent development of ICT technology, various fields are realizing that not only are smartphones becoming more popular, but they are also becoming an integration of the latest technologies. In everyday life, an environment has been created where payments can be made quickly and easily with the touch of a smartphone, even when riding a bus or making a payment at a store.

This paper aims to develop a cafeteria management system using NFC technology based on the operation cases of large-scale workplace cafeterias to improve them. The structure of the paper is as follows. This paper seeks to develop a cafeteria management system using NFC technology to improve the operation case of a large-scale cafeteria. The structure of the thesis is as follows. Chapter 2 explains the concept and characteristics of NFC, Chapter 3 describes the cafeteria management service based on this, Chapter 4 presents a cafeteria management system using NFC technology, and finally concludes.

2. Related Works

2.1 NFC

NFC (Near Field Communication) is a wireless communication technology and can be considered short-range wireless communication. One of the most common examples is when dining at a restaurant, where after the meal, you check the bill and then approach the payment terminal with your smartphone to make the payment. In addition, mobile postpaid transportation cards used when using city buses or subways also use NFC technology instead of existing plastic transportation cards. NFC is the shortest range wireless communication technology. Two NFC-compatible devices must be located within a distance of 4 cm or less to communicate with each other, and has a band of 13.56 MHz. Additionally, information can be transmitted at speeds ranging from 106 Kbit to 424 Kbit per second. NFC communication utilizes an RF (Radio Frequency) chip, which plays a role in converting digital signals from the modem chip into analog signals for wireless frequency transmission, or converting external signals into digital signals for transmission to the modem[3]. In two devices communicating, one is the active device as an initiator and acts as a leader to initiate communication. Another device is a target, which acts as a tag that responds to the sender's request. At this time, the target can be active or passive. When the transmitter, which is an active device, approaches the target device, it generates a magnetic field of 13.56 MHz and supplies power to the target device, and communication begins [4, 5]. Compared to another wireless communication technology, Bluetooth, NFC has several advantages. Firstly, it consumes less power, so while Bluetooth continuously drains the smartphone's battery if left on, NFC consumes less power as it only requires scanning the device for payment. Second, NFC operates at a distance of 4 cm or less, so it is safer than Bluetooth, which has a longer distance, and is less likely to be hacked and file loss. Third, Bluetooth requires pairing to share files, but NFC is a two-way communication that can both read and write data, so pairing is not necessary. NFC communication method has active mode and passive mode. In active mode, two NFC devices act as both reader and tag devices, communicating via peer-to-peer (P2P) communication using RF fields. In passive mode, the transmitter generates the RF field, and the target device responds, constituting communication between reader and tag devices[6-9].

3. Cafeteria management system

3.1 System overview

The COVID-19 pandemic, which has brought major changes to our lives and environment over the past few years, has also had a significant impact on our eating habits. Environmental changes that have caused inconveniences in daily life, such as social distancing and mandatory wearing of masks indoors, have had a significant impact on dining culture along with the increase in the number of single-person households. Reflecting this, the restaurant sector is also showing a different form from the past. Korea also declared an endemic on May 11, 2023[10], making daily life more natural, but the number of office workers using cafeterias has increased sharply due to the high rate of increase in food prices. In this paper, we propose a cafeteria management system to operate the cafeteria more systematically in response to the increase in the number of cafeteria users. The cafeteria management

system developed in this paper includes menu selection, payment, and seat status for users who visit the cafeteria.

Figure 1 shows the overall configuration of the cafeteria management system. Customers intending to use the workplace cafeteria carry smartphones. Upon entry, they bring their smartphones close to the NFC reader. The NFC reader then transfers the NFC tag information to the management PC connected to it. Subsequently, the management PC forwards this information to the management server located remotely. The management server that receives this information checks the user information in the database and notifies the smartphone that the user information has been confirmed. The next task is to display user information on a monitor connected to the management PC, as well as the status of empty seats recorded on the management server and today's menu based on the weekly menu. After selecting their desired menu on the monitor, customers can proceed to use the cafeteria. The cafeteria management system stores information such as the price of the selected menu and the time of purchase in the purchase records. It also counts and stores the seating availability on the seating chart, aiding the next customer in menu selection upon entry.

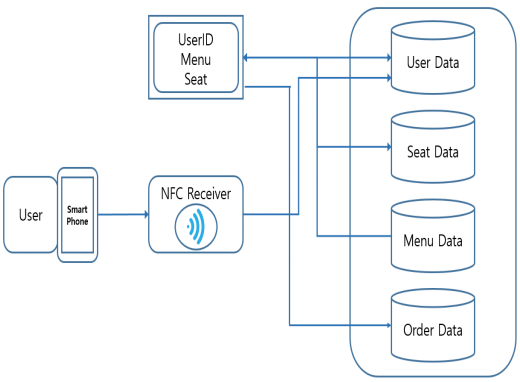

Fig. 1. System Structure

3.2 System application method

The facilities and worker status for applying the system proposed in this study are as follows. The number of employees is about 1,500 in 1 department, 3 offices, 64 departments, and 3 teams, and about 2,500 including partners. The average daily number of users of the cafeteria is approximately 2,000, and they use the cafeteria twice a day for lunch and dinner. The results of analyzing the current situation considering the number of workers and restaurant space can be summarized as follows.

If more than 2,000 people use a restaurant at the same time, there is a lack of space and the waiting time is long, which causes inconvenience to users, such as not being able to eat during lunch hours. To resolve this issue and prevent the spread of infectious diseases such as COVID-19, restaurant operating hours are separated by location. As can be seen in Figure 2, the current system is operated to display the selected menu and customer name along with a card reader and a keypad for menu selection. If a cafeteria user inadvertently passes by the card reader without tapping their ID card, it could result in a deficit due to the discrepancy between the number of cafeteria users (for payment settlement, e.g., 1450 people) and the number of meals distributed (for cost calculation, e.g., 1500 people). To prevent this, cafeteria operators must always pay attention to whether cafeteria users properly tap their cards and often assign someone to monitor this process. Therefore, to reduce the need for constant monitoring and avoid unnecessary attention, it is necessary to enhance the cafeteria usage system with NFC technology to automatically identify users during cafeteria usage. This enhancement ensures that the number of diners and the number of meals distributed match seamlessly.

Fig. 2. Current system operation status

4. System processing procedure

4.1 Customer confirmation

The method for confirming customer entry into the workplace cafeteria utilizes NFC technology on a smartphone. NFC tags are installed at the entrance or ordering counter of the cafeteria, and customer entry is confirmed as their smartphone recognizes the NFC tag. Figure 3 shows the code to perform this task.

```
Initialize the NFC adapter using NfcAdapter.getDefaultAdapter(this).
Check if the device supports NFC
Check if NFC is enabled:
Call handleNfcIntent() with the new intent to process any NFC tag scans.
Get the action from the intent.
Check if the action is NfcAdapter.ACTION_NDEF_DISCOVERED
```

Fig. 3. Customer confirmation code

In Figure 3, the NFC adapter is initialized and whether the NFC function of the smartphone is activated is checked. When activated, customers are identified through NFC tags.

4.2 Transmission of customer information

When a customer scans the NFC tag and enters the cafeteria, the information is transmitted to the cafeteria menu selection system and the customer's name appears. To achieve this, the customer's NFC tag information is transmitted to a server or database, and the information is received and processed by the restaurant's menu selection system. Figure 4 shows the code to perform this task.

```
Initialize NFC adapter
Call handleNfcIntent() method to handle NFC tag scan.
If the action indicates an NFC tag scan
Create customer information
Send customer information to the server
Call sendDataToServer() method passing customer information.
Send the provided data to the server
```

Fig. 4. Customer information transmission code

In Figure 4, after initializing the NFC adapter performed in the previous step, the customer who entered the system is checked through the NFC tag and sent to the server to confirm the customer information.

4.3 Order screen display

After the customer's name appears in the cafeteria's menu selection system, an ordering screen is displayed on the host PC's monitor. It receives the customer name, registers the customer in the restaurant system, and displays a screen where the order can be processed. Figure 5 shows the code to perform this task.

```
Initialize OrderWindow
Set text to "Customer Name: {customer_name}"
Set text to "Available Menu:"
Create list of menu items
Add customer_label to layout
Add menu_label to layout
Add each menu_item_label to layout
Set customer_name to "Customer Name" (received from the restaurant menu selection system)
Show the OrderWindow
```

Fig. 5. Order screen display code

Figure 5 shows the process by which the

menu available for ordering that day appears in the menu selection system along with the customer's name confirmed through the NFC tag.

4.4 Menu selection

When a customer selects a menu in the menu selection system, order information is displayed on the restaurant screen and purchase details are simultaneously recorded in the customer information table on the database server. Additionally, to manage purchase history on a monthly basis, order details are recorded and aggregated on a monthly basis. Figure 6 shows the code to perform this task.

```
Connect to SQLite database
Create 'purchase_history' table
Commit changes to the database
Display order information on the restaurant screen:
Record purchase in the database:
Connect to 'customer_info.db'
Record current date and menu order in the 'purchase_history' table
Commit changes to the database
Close the database connection
```

Fig. 6. Menu selection code

Figure 6 shows the process of adding purchase details, including date and menu, by accessing the customer information table on the server when a customer selects one or more menu items.

4.5 Order processing

The ordered menu is displayed on the order screen in the kitchen, and the order status is sent to the customer's smartphone. Figure 7 shows the code to perform this task.

```
Initialize OrderDisplay
Set orders attribute to the provided orders list
Add customer name and ordered menu to the table
Call display_order method of kitchen_screen with menu_item
Define send_message static method
Set customer_phone to the customer's phone number
Create message informing the customer about their order
Set message to be sent via KakaoTalk
Call send_message method of KakaoTalkAPI with customer_phone and message
```

Fig. 7. Order processing code

Figure 7 shows the process in which the menu selected by the customer is displayed on the screen installed in the kitchen, and the order is delivered as a KakaoTalk message to the contact information registered in the customer information.

5. Conclusion

In a difficult situation due to a long-term economic downturn and the COVID-19 incident, small business owners who run restaurants are having a harder time with a decrease in the number of customers. In addition, due to the high inflation rate of eating out, the number of office workers using cafeterias is increasing to reduce meal costs. In this study, we analyzed the current status of cafeterias with a large number of customers and proposed ways to improve problems or difficulties. Since most people carry smartphones, we would like to develop a restaurant management system that uses the NFC function of smartphones, suggesting a process from customer entry to menu selection, which could enable more efficient restaurant use. In the future, we plan to study the convergence of hardware and software that can handle the step-by-step process in an integrated manner.

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