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Study of Smart College Canteens from the perspective of Internet of Things

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ABSTRACT
Recent years, with the development of the era of big data, the construction of smart canteens as an important part of smart campus has attracted increasing attention. Since the outbreak of Covid-19, it is increasingly urgent to accelerate the construction of smart canteens in particular. In addition, Internet of Things has greatly promoted the rapid development of smart canteens. This paper introduces the new exploration of China University of Geosciences (Beijing) in the construction of smart canteens. Based on Internet of Things technology, Smart College Canteens has been developed with the help of mobile Internet, big data and cloud computing. The platform has changed the traditional consumption and operation mode of canteens on campus currently so as to create a brand-new management system for the convenience of students. Furthermore, it realizes the refined management and intensive management, improves the service, guides a healthy diet for students and teachers, and improves the efficiency and level of logistics in canteens.

Keywords: *Smart canteens, Internet of Things, cloud butler platforms, management of college canteens, smart campus, college logistics.*

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INTRODUCTION

Since the outbreak of Covid-19, the Party's Central committee and local governments have attached great importance to the prevention and control of the epidemic and actively responded to it, which effectively curbed the spread of Covid-19. At present, as the situation has improved greatly in China, the epidemic prevention and control has shifted from the emergency control to the normal management. However, it is not a problem we should take lightly. After the beginning of a new term, the prevention and control in colleges and universities will face greater challenges. Among them, the safety of meals is one of the most difficult problems. It is necessary to avoid the spread of the epidemic caused by gathering.

In traditional canteens, there are some common problems including concentrated dining hours, large flow of people and crowded queues. In addition, students often need to line up several windows to get food because of the single mode which also increases the density of people in need.

Recent years, colleges and universities have increasingly participated in major national political, economic and sports events. Those events are often featured as a large scale with long time, a great number of people and food in need. Therefore, there are some potential problems in food safety. Furthermore, according to the traditional management mode, it is difficult to accurately count the number of diners. As a result, it is often prone to waste or prepare too much.

As CPC General Secretary Xi Jinping proposed a strategy of “Healthy China 2030”, “Internet + Nutrition and Health” service has been piloted in China (National Nutrition Plan (2017-2030)). In order to face the challenges of Covid-19 and the traditional mode in canteens, “Internet of Things + Catering Service” have laid a theoretical foundation for colleges and universities to rethink and position the role of catering services.

China University of Geosciences (Beijing), as a world-class discipline construction university with nearly 20,000 people (selected in September 2017), has a great number of students but weak dining condition. Students are mainly concentrated in a three-storied building consisting of 3 student canteens with insufficient catering area, which increases the risk of the spread of the epidemic caused by gathering. Meanwhile, there are some common problems of traditional canteens including concentrated meal times, crowded queues at peaks and low satisfaction of students. Besides, China also faces new challenges in colleges and universities. For example, diversified dining demands put forward some individual needs, such as sports meals and nutritious meals.

In order to deal with the problem of dining for teachers and students during Covid-19 and post Covid-19, based on the concept of "Internet of Things + Catering Service" and the advantages of mobile Internet technology to change the traditional dining mode, this research has developed a cloud butler platform for smart canteens to transform traditional canteens into new ones with a safety and health, scientific and efficient, flexible and convenient student meal management system, at the core of teachers and students demand and with the principle of online order, limited serving time and separated eating time. In this way, college canteens can realize refined management and intensive management to improve the service, guide a healthy diet for students and teachers, and improve the efficiency and level of logistics.

THEORETICAL BASIS

Kevin Ashton, as the co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), first mentioned the internet of things (IoT) in a presentation he made to Procter &Gamble (P&G) in 1999. He describes the IoT as "the network of physical objects, embedded with sensors, software and other technologies to connect and exchange data with other devices and systems over the Internet" [2]. According to the definition of Alexander S. Gillis, the internet of things (or IoT) is "a system of interrelated computing devices, mechanical and digital machines, objects, animals or people" [1].

An IoT ecosystem uses embedded systems to collect, send and act on data gotten from the environments (Figure 1). It can also use artificial intelligence (AI) and machine learning to raise efficiency of the data collecting processes. With the usage of IoT, it can monitor their overall business processes; improve the customer experience (CX); save time and money; enhance employee productivity; integrate and adapt business models; make better business decisions; and generate more revenue [1].

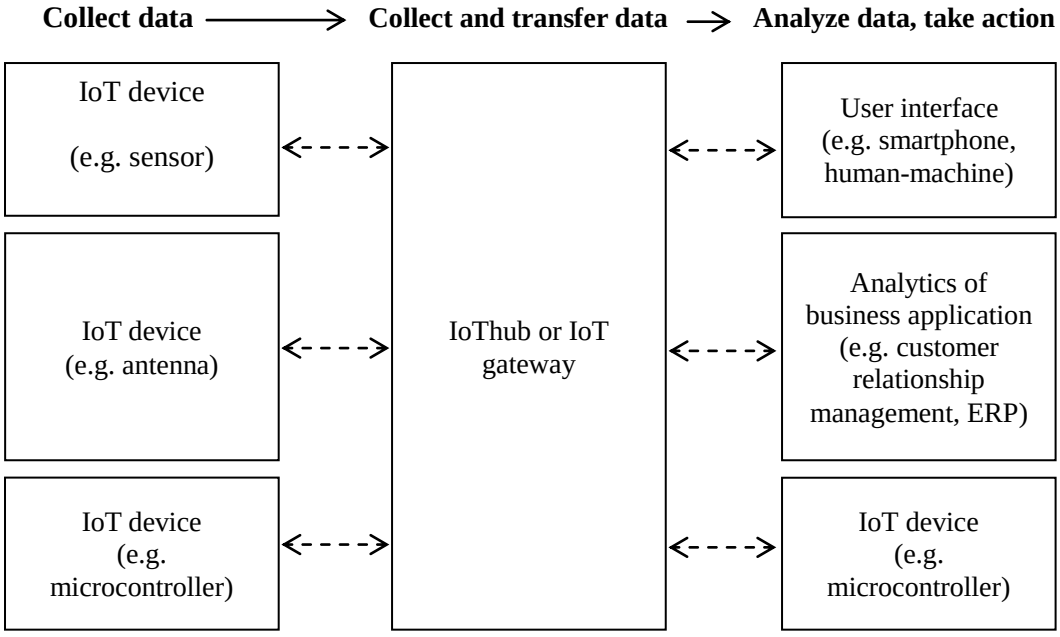

Figure 1: The Running Mode of an IoTSystem [1]

DESIGN OF SMART COLLEGE CANTEENS

Design Ideas

In order to deal with the problem of dining for teachers and students during and post Covid-19, mobile Internet technology is used in China University of Geosciences (Beijing). It tries to change the traditional dining mode create a brand-new smart college canteen on the basis of "Internet of Things + Catering Service". The design ideas are as follows:

1) Develop a cloud butler platform for smart meals based on mobile Internet, big data and cloud computing, so as to use mobile Internet technology to order meals online and choose dining methods, times and locations; divert the crowd in the canteen to effectively reduce gathering and realize eating in different times.
2) Use technologies such as big data and artificial intelligence. Take online orders into consideration. The canteen's supply chain from procurement to dining can be managed and realize a more scientific, efficient, and platform-based management solutions. It would make logistics catering management simple and ensure the food safety. In this way, raw materials and dishes can be ordered quantitatively and reduce the waste thoroughly.

3) Solve the problem of online ordering and offline delivery. Through contactless pickup, the transmission of Covid-19 can be cut off effectively. As for students ordering online, they can choose to eat in or take out. And then the canteen will deliver the take-out food to the self-service vending machine designated by the student.
4) Through the analysis of online ordering data for the faculty and students, provide rationalized meal suggestions for them to eat a healthy diet.
5) Establish a teacher-student feedback system. The faculty and students can evaluate the dishes.Thus, data can be analyzed regularly. Find out reasons for the dishes with low evaluation and poor sales, and continuously improve the quality of the dishes.

This platform makes full use of advanced technologies including mobile internet, artificial intelligence and big data to create a safe, hygienic, scientific, efficient, flexible and convenient meal system for colleges through the principles of online ordering, limited flow and time-sharing dining plan.

The faculty and students can make reservations for ordering and picking up meals through the application. The whole process is non-contact effectively preventing secondary infection and minimizing the possibility of clustered epidemics. The administrator sets the number of people who take meals in each canteen and during each time period in the system according to the reality. After the merchant uploads the pictures and prices of dishes to the platform, users can reserve dishes and time on mobile phones. As the meal pick-up code is generated after payment, students are able to pick up their meals in accordance with reservation time and the ordering number. Meanwhile, the personnel in the reservation time period can also be synchronized to the identification system for security. Verification is carried out when entering the restaurant at the entrance, and they are not allowed to enter the canteens beyond pick-up time.

Overview and Function Smart College Canteens

Based on the Internet of Things technology, a cloud butler platform for smart college canteens has been developed based on mobile Internet, big data and cloud computing. Smart college canteens mainly include four parts, namely management, merchant, user and the interface. The functional process is shown in Figure 2. The platform supports the one-card administrator account and password to log in, and completes the setting of ordering and reservation rules for the entire school through operations in canteens, merchants, reservation rules and so on. Based on this platform, it is possible to order meals online, choose the method of delivery, time and location, and then to divert the crowd in the canteen, effectively reducing gathering. Through Smart College Canteens, users can order food on the mobile phone, as they can order a single dish or directly order a set. The dishes are published by merchants, and the pick-up and delivery method can also be set by them, which can be self-pickup or delivery. The merchants can connect to a Bluetooth speaker printer without a computer to broadcast and automatically print receipts. In addition, it can be connected to smart cabinets which could make full use of mobile internet, artificial intelligence and big data. Through online ordering, limited flow and time-sharing, a safe, hygienic, scientific, efficient, and flexible dining service has been provided for colleges. It can effectively reduce contact among people, prevent secondary infection, minimize the possibility of clustered epidemics, and comprehensively protect the health and safety of teachers and students in colleges and universities.

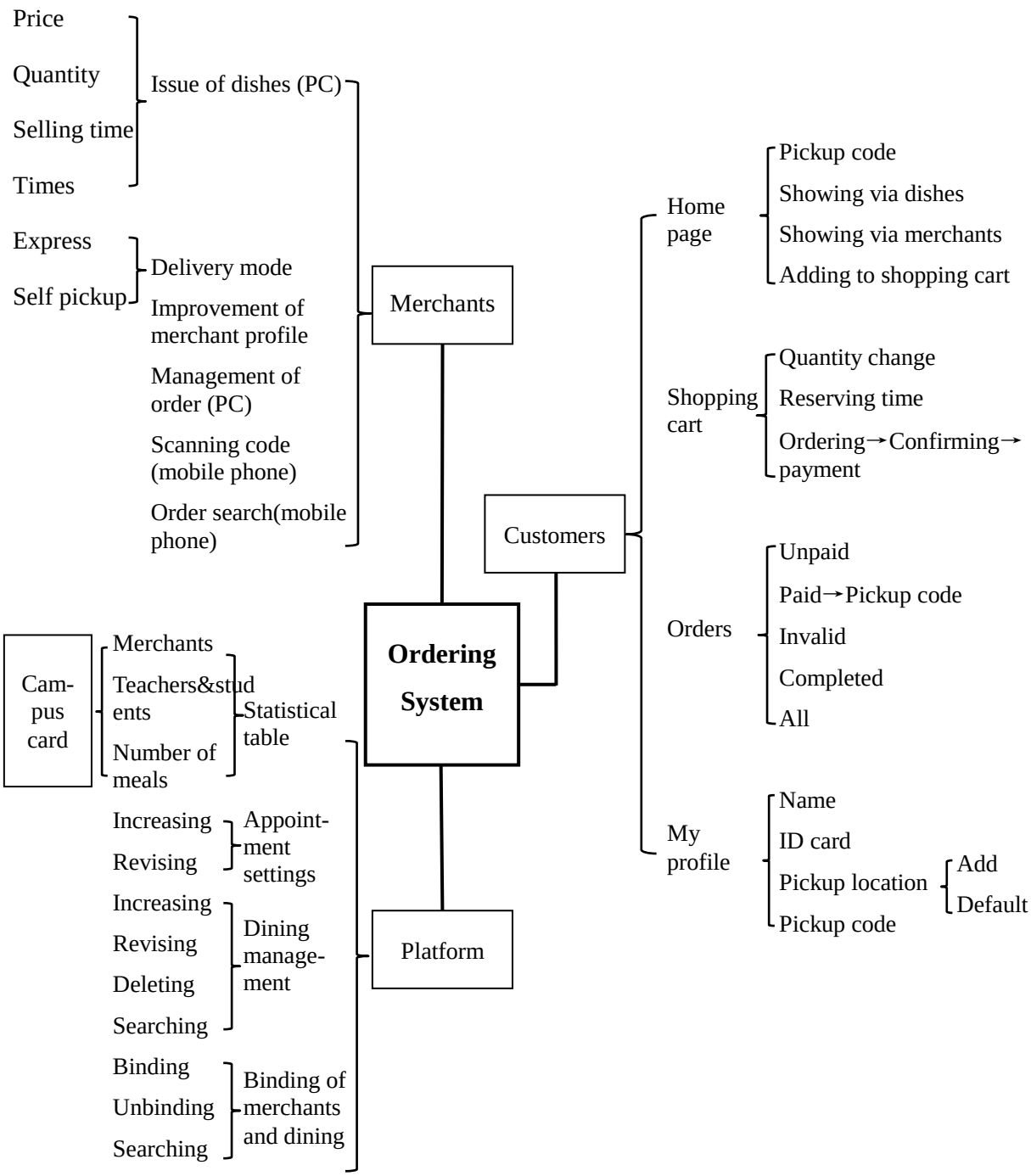

Figure 2: Functional Flow Chart

(1) Management

The management is responsible for the setting of some basic parameters of the system, including preferences, dining management, binding between canteens and merchants, setting of reservation rules, binding between merchants and ID numbers, etc.

a) Preferences

Preferences stands for the basic parameter setting of the system, mainly used to set the deadline for reservation. After a certain time, the channel for reservation will be closed. The administrator can flexibly set the time according to the situation of colleges and the working time of the merchant.

b) Dining management

To achieve on-campus ordering reservations, it is necessary to manage each canteen. The administrator can maintain the restaurant information through the dining management. One can input basic information such as the name of the canteen for the binding of merchants in the future.

c) Binding between canteen and merchant

The administrator can bind the merchants (the information of merchants comes from the student card, without inputting into the system) with the canteen, and all the bound merchants will share the reservation rules of the corresponding canteens. It also supports the unbinding.

d) Appointment settings

The administrator can set the beginning and ending of each meal, the time interval, and the number of people who take meals in each restaurant in a certain period.

e) Binding between merchant and ID number

The administrator can bind the merchant number with ID card in colleges, so that the merchant will directly jump to the merchant page after entering the ordering system.

(2) Merchant

Merchant supports login with the account and password of the student card. Merchants can publish the packages they sell to users on the platform, view the detail information of orders and prepare meals accordingly. It is divided into two entrances: from personal computer and from mobile phones. Merchants mainly publishes products, line items, product lists, settings, orders-received statistics, combination statements, statistical statement and so on from PC, while code to pick up meals and line items from mobile phones.

a) Meals

Merchants can publish the meals they sell to the ordering platform, so users can view and place orders on mobile phones.

b) Improvement of Merchant Profile

For a better management, the system will require merchants to fill in the phone numbers and names as logging in for the first time.

c) Shipping Settings

If the number of students in school is quite small, shipping ways can be set to “delivery”; otherwise, “self-pickup”. (Users go to the stall to pick up their food)

d) Product list

Users can view the product information released by the merchant. It also supports inquiry and removal.

e) Statistical Table

Orders-received statistics support querying the number of reservations for different products throughout the day (whether to display the pickup time: No), and also in different time periods throughout the day (whether to display the pickup time: Yes). When the users chose delivery, the pick-up time is alternative.

f) Order details

Here you can see the product details of each user, which can be used to package each order. The same order number represents the same order and should be packaged together.

g) Code to pick up the meal (mobile phones)

When the user picks up the meal, the merchant can scan QR code to verify whether teachers and students can pick up the meal during the time period, check the dishes ordered by the user, and finally complete the order.

h) Order details (mobile phones)

Merchants can view the dishes ordered by the user on the mobile phone, and can check it through options such as only viewing yesterday's orders, hiding customer names, and only viewing undelivered orders. Unfinished orders can be managed through viewing phone number, address and other information to ensure efficiency and convenience of delivery.

(3) User platform

The user platform stands for ordering/pick-up and inquiry for users who can check from mobile phones. They can select the reserved dishes as they like, choose the time to pick up the meal, pay for it, check orders and so on.

After logging in to the ordering system, the user can order the meals uploaded by the merchant according to the rules set by the administrator. After the payment, one can pick up the meal with QR code next day.

Process: browse the meals- add to the shopping cart - make an appointment of time- place an order - confirm the order - pay - generate a code - scan the code/swipe card to pick up meals.

a) Home Page

✧ Address

Displays the default delivery address set by the user. If the user does not set it, there will be a notification. Clicking it will jump to add My Address.

✧ Code

Jump to my code for a quick pick-up.

✧ Reservation Deadline

It is used to control the deadline for the reservation of dishes, and reservations are be closed after the deadline.

✧ Display by Meals

Meals will be displayed in a reverse chronological order. The name of the merchant is displayed on the top of pictures, the name and details are displayed on the right, and time for pick-up is displayed on the bottom.

✧ Display by merchant

All merchants will be display. Click a merchant's name to enter the menu page, and display its all meals, which is convenient for users to remember and quickly select dishes from a certain merchant.

✧ Addition and subtraction of meals

Add or subtract dishes, which means users are able to increase or decrease meals. With the change of meals, the shopping cart will also increase or decrease accordingly.

✧ Choose the time to pick up the meal

When choosing to add a meal, the user will be prompted to select a certain time. All available time will be displayed for the user, whether the appointment is full in each time will be displayed. Clicking the blank area is to cancel.

✧ Settlement

Settlement on the homepage can be settled immediately, click to jump to pay for it and select the mode of payment.

b) Shopping Cart

✧ Select all meals or a single one

It supports settlement after selecting a single dish and all dishes.

✧ Display dishes

Displays the dishes and quantities selected by the user.

✧ Addition and subtraction of dishes

The user can increase or decrease the number of selected dishes.

✧ Choose the time to pick up the meal

When choosing to add a dish, the user will be prompted to select a certain time, and all time periods under this meal will be displayed for the user. Whether the appointment is full within each time period will be displayed. Click a blank area to cancel.

✧ Settlement

Click it to jump to the pay for your meal and select the mode of payment.

c) Payment

✧ Pending payment

When the user fails to pay or cancels the payment, the order will enter the pending payment.

✧ Shipping address

When the user chooses the delivery, the payment page will display the user's default delivery address. The user will be prompted to choose a default address if one does not set it.

✧ Mode of Payment

WeChat pay, student card payment, and student card payment of debit.

✧ Payment completed

Display the result of payment if it is successful.

d) Order

✧ All

All order details of the user.

✧ Complete

The finished orders.

✧ Pending meal

The orders which the user has paid but has not yet picked up.

✧ Pending payment

The user has placed an order but has not paid for it as he can choose to cancel or re-pay.

✧ Failure

The order that the user has not completed the payment within the specified time.

e) My

✧ Information

The user's basic information includes name, ID number, etc.

✧ Meal address management

Users can then add, delete, and modify their addresses.

✧ Code

Show the code to pick up meals.

(4) Platform interface

The platform interface is the data for connecting with the student card. It is used to synchronize the basic information, credit, campus, merchant information, and the binding relationship between merchants and POS.

3.3 Results of Smart College Canteens

The cloud butler platform uses technologies such as big data and artificial intelligence to carry out refined procurement, supply chain management and inventory management for canteens, which can ensure the scientific and efficient procurement and supply process of canteens. The safety of catering has been improved, and the canteen is able to order a certain number of raw materials and dishes to avoid waste accordingly.

Furthermore, Smart College Canteens also improve the satisfaction of teachers and students through online ordering, off-peak dining, and advance reservations, which has simplified meal selection and reduced the queuing time. It solves the problem of on-campus dining by increasing the capacity and managing costs and processes orderly. The problem of the year-on-year growth of the number of people is solved as well. Meanwhile, the analysis of the online ordering data provides teachers and students with reasonable meal suggestions to achieve a healthy diet and to solve the year-on-year increasing people and to solve the diversified needs. Students and teachers can evaluate the dishes. Through analyzing the data regularly, find out the reasons for the dishes with low evaluation and poor sales, so as to make improvements. In this way, students and faculty on campus will bear a good dining experience.

Accurate statistics on the number of personnel participating in major security tasks, meal time and location can be calculated by big data, so that meals can be prepared accurately, safely and timely.

Online and offline connectivity to ensure accuracy: after receiving the order, the system automatically prints a receipt, and chefs prepare meals according to it. When students pick up their meals, check the receipt and use the machine at the window to identify the code on the mobile banking to write off the order.

Mobile management, get the information at any time: management system can be use on mobile phones convenient for staff in canteens.

CONCLUSION

Based on Internet, big data and artificial intelligence, Smart College Canteens can not only better cope with emergencies such as epidemics, but also adapt to the trend of big data at present and in the future, thus to promote the development of smart canteens in colleges and universities.

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