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Smart Buffet Food Tray

Muhamad Zuraidi bin Rohani, Mohd Fakhrur Razi Misran & Zikri bin Zakaria

Jab. Kej. Mekanikal, KM 22 Jalan Matang, Politeknik Kuching Sarawak, 93050 Kuching, Sarawak, Malaysia.

zuraidi90v@gmail.com

ABSTRACT
Food and beverage services are synonymous with excellent hygiene during the handling process. Most service providers are fully committed to reducing any contamination factors. Unfortunately, the variable in this case, which involves the human element, is unpredictable. A problem revealed by a case study stressed on the application of the food tray. Improper management of food during an event can expose it to potential hazards. Therefore, this research project addressed the implementation of a smart buffet food tray with a sensing element. This project was aimed at reducing any direct contact between humans and the lids of the trays as well as the period of exposure of food to the surroundings.

Key Words: Smart Food Tray, Food Handling

1. INTRODUCTION

Safety is a common issue of discussion in various fields of activities, including food servicing and management. It is essential to provide a solution to improve food safety and hygiene practices. One of the approaches is the development of an automatic food tray. Currently, the research trend is towards designing and developing a smart device related to automation and electronics. The latest on the Internet of Things (IoT) is directed at increasing work efficiency in comparison with human production. The food servicing industry is not excluded from technological adaptations. Therefore, this research project presented a cost-effective smart food tray, where the opening and closing of the lid is controlled in the system by sensing the weight of ladle. A literature review was carried out on the effects of contaminated food, the significant factors of food poisoning, and typical products that have adopted sensing elements.

2. LITERATURE REVIEW

Food poisoning or food-borne diseases have become one of the grave concerns around the world as about 30% of the majority of illnesses are related to the food industry, as announced by the World Health Organization in 2014. Contaminated food is due to the spread of various microorganisms, such as bacteria and viruses, which are a potential source of hundreds of illnesses, as experienced in the United States, where thousands of people are hospitalized due to contaminated food. Many variables should be considered in managing the processing and servicing of food (Kamala & Kumar, 2018). The prestigious and exciting food servicing that is provided by many companies has attracted people, especially urban residents, to have their meals outside instead of eating home-cooked meals (Angulo, Jones, & Angulo, 2006). It has been recorded that 52% of food poisoning cases is caused by eating in restaurants.

The increase in the number of customers in the food industry has had a positive impact in terms of employment. The demand for employees has resulted in migrant workers coming in to fill the vacancies. However, food poisoning cases from a single cluster keep increasing every year, where food poisoning in schools reached 8000 cases in 2015 from 3822 cases in 2005 (New et al., 2017). One of the most significant factors that contribute to food contamination is the improper handling of equipment during food processing and servicing. For example, there is a high chance of insects crossing over and spreading pathogens to food that is exposed for long periods in the open without careful observation. Apart from that, the lack of knowledge about food hygiene and food is another factor that contributes to food-borne diseases. In response to this situation, it is necessary to apply technology to food servicing, such as the application of a smart trash bin (Girdhar, Raval, Pathan, Patidar, & Gurjwar, 2019) by using Arduino to provide a solution.

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3. METHODOLOGY

In the development of product innovation in food servicing and management, several elements in Quick Service Restaurant Chain (QSRC) product innovation steps (Cooper & Edgett, 2010) was adapted. These steps are applied in research methodology framework as described by (Hemant M. Patil, Saurabh S. Sirsikar, & Nitin N. Gholap, 2017). The study begins by defining the problem, generating the idea and concept from a single case study at a restaurant in Kuching Sarawak and overall flow process is shown in Figure 1.

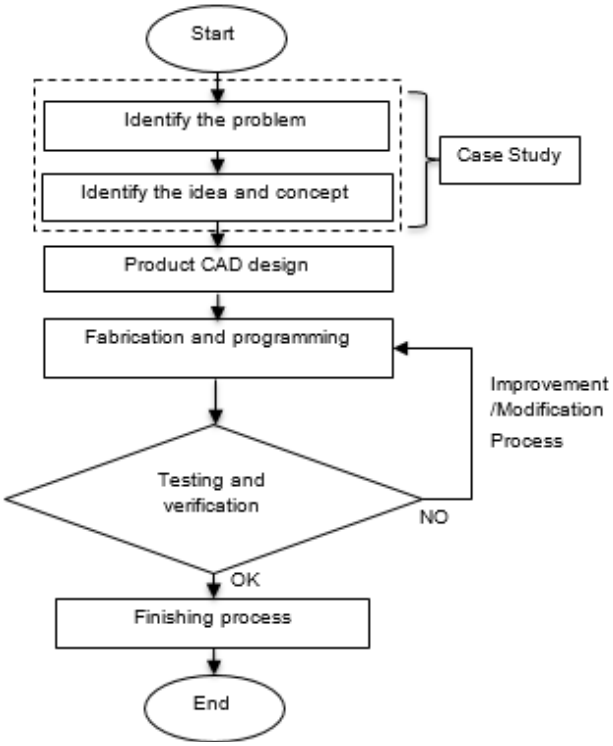

Figure 1: Overall Methodology Process

Design of Case Study

The case study was conducted with an open-ended questionnaire and site observation, where it allows the flexibility in responding to any kind of question from the respondent while gaining in-depth knowledge related to the restaurant operation. The questionnaire applied during the case study is shown in Table 1. Due to the mutual agreement and confidential issue, the company is named as Company A.

Table 1: Case Study Open-ended Questionnaire

No.	Questions
1	How long have you been in the food servicing industry?
2	How many employees work at your company?
3	What is your core or primary business activity in the service industry?
4	What is the main challenges in current practice?
5	What would be your suggestion for the improvement?

4. RESULTS AND DISCUSSION

4.1 Case Study: Company A

Company A is an enterprise company in the food servicing industry in Kuching with twenty employees includes full time and part-time position. The main activity of the company is serving varieties of food with buffet style. During the case study, the manager has mentioned that the main challenge is handling the food during the event. The food was longer exposed to the surrounding and it could not maintain the warm condition as well as increase the chances of insect crossing the food in the tray. It was suggested by the owner to have an automatic food tray by means the lid can be open and closed automatically.

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Therefore, this study was proposing a smart buffet food tray which using electronic and sensors such as an Arduino and weight sensor as part of the operating system as explained in section 4.2.

4.2 Product Design and Development

Arduino was applied as the control unit and was attached to the hardware. The basic Arduino code logic was an “if-then” structure that could be divided into a few blocks as the setup. It will usually be written in the setup section of the Arduino code and performs what needs to be done only once, such as with a motor. The input was required at the beginning of the loop, and this input would be read. Values, such as the ambient light reading from an LDR using the analogue Read (), was used as the conditions (“if”). The output was defined as the final outcome of the logic (“then”) according to the data calculated in the previous step. Looking at the example of the LDR and PWM, the LED was only turned on when the ambient light level went below a certain threshold. Figure 2 shows the Arduino circuit diagram that was applied in this project, while Figure 3 shows the 3D drawing design.

The Arduino board is connected to a computer via a USB, which then links it to the Arduino development environment (IDE). The user writes the Arduino code in the IDE, which then uploads it to the microcontroller to execute the code, thereby interacting with the input and output of the motor. Arduino provides a better solution since it is ready to use as its structure comes with a complete package. Furthermore, the precision-based limit can be controlled with DE software on any operating system (Verma, 2017). Despite its advantages, the Arduino libraries are not very efficient in certain parts.

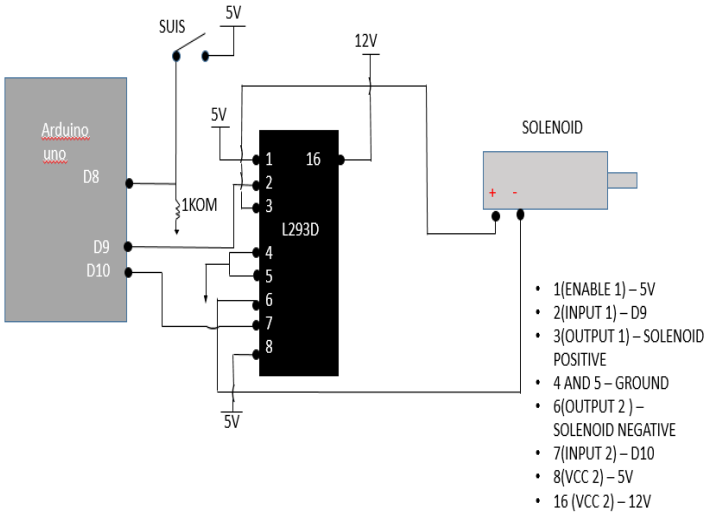

Figure 2: Arduino Circuit Diagram

The system requires programming an Arduino UNO as an ECU unit connecting both the hardware and sensor. Upon activation of the smart food tray, the sensor will measure and record the weight of a ladle placed outside the food tray. Once the sensor indicates that the weight of the scoop on the plate has been reduced, the lid of the food tray will automatically open until the ladle is placed back in its position. Then, the cover will close automatically. The essential operation of this system is shown in Figure 4.

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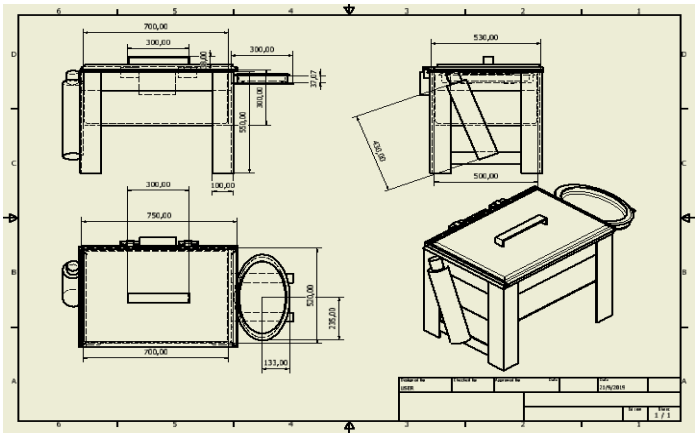

Figure 3: 3D Product CAD Drawing

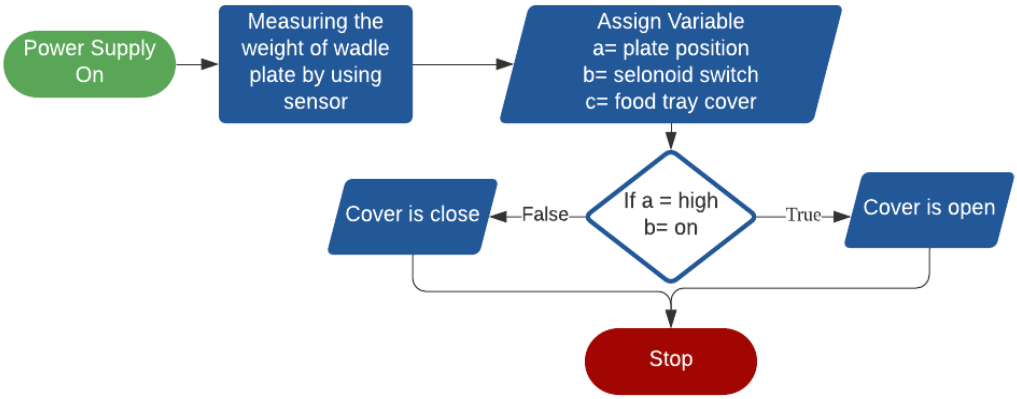

Figure 4: Decision Programming Flow Process

Upon completing the fabrication process, the functionality of the smart food tray was tested at a real event. The system worked successfully according to what it was programmed to do. The cover of the food tray opened to a 90-degree position within 10 seconds, and the same went for the closing operation. In terms of power consumption, the system was able to operate for a full day before having to be recharged for 1 hour since it only used a 2200 mAh Li-po battery. In terms of cost, the system consumed around RM274.25 for its original equipment. However, the cost invested in this technology for one food tray would be for at least six days of operation, which is equivalent to RM50 for a part-time worker's salary. The final product is shown in Figure 5, while, Table 2 shows the overall cost to develop the system, including the cost of a complete stainless-steel food tray set.

Figure 5: Smart Buffet Food Tray

Table 2: Overall Development Cost

No	List of parts	Quantity	Cost/item (RM)	Total (RM)
1	Arduino UNO	1	20.00	20.00
2	Linear Actuator	1	86.95	86.95
3	Rivet	1	14.00	14.00
4	Rivet pop bolt	2 packets	1.20	2.40
5	Stainless Steel Food Tray (Full set)	1	109.00	109.00
6	Aluminium Frame	1	18.00	18.00
7	Light Glass	1	30.00	30.00
8	Ladle	1	5.70	5.70
9	Rechargeable battery 11.1V	1	65.90	65.90
10	OMRON Limit Switch	1	18.00	18.00
11	Hinges	2	2.50	5.00
12	Ladle plate	1	2.50	2.50
13	Screw	2 packets	1.50	3.00
14	Button switch on/off	1	2.00	2.00
15	Bush	2	0.60	1.20
16	Arduino casing	1	13.00	13.00
17	L shape metal bracket	3	0.50	1.50
18	Silicon rubber	1	7.50	7.50
19	Jumper	1 packet	3.00	3.00
20	Wire	1 meter	0.80	0.80
			Total	383.25

5. CONCLUSION & RECOMMENDATION

This project is focused on redesigned the manually-operated chafing dish into a smart lid food tray. The primary purpose is to reduce the direct contact between human with the lid of the food tray in order to maintain food hygiene. The proposed concept and design was successful fabricated and it provides caterers with an effective way of managing the operation of buffet food trays. The lid of the tray is automatically open and closed depending on the weight sensor applied in the system. Therefore, the objective of this project has been successfully achieved.

However, there are several improvements that can be made in future research projects. A sensitive weight measurement should be applied since the current system is unable to detect lighter weights such as a spoon or fork on the plate. In addition, the product should be designed so that it can be easily disassembled from electronic devices for cleaning purposes.

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