Sanitation and Safety in Food Vending Machines in a Public University: A Preliminary Study of Standards and Practices

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ABSTRACT

The demand for vending machines has significantly increased in a current modern lifestyle with a tight schedule and limited time. However, there is a critical concern to guarantee buyers about the safety of foods and drinks sold in vending machines. Therefore, this research aimed to identify the level of quality and safety parameters of food and drink products sold in the vending machines with the application on mixed methodology. For the quantitative data, structured observations were conducted on 15 food-handlers of the vending machine located in a tertiary educational institution in Selangor, Malaysia. The key results showed that the awareness of food handlers regarding the safety and quality of vending machines in the institution is poor due to the lack of training in food safety and hygiene. Currently, the food handlers are usually based on their experience, logic and common sense because they did not have any Standard Operation Procedure (SOP) towards the vending machine. The critical criteria for vending machines, safety and quality are the cleanliness of the machine and the surroundings, the equipment used, the products, the replenishing staff, the vehicles and transportation and the location of the machine. This study shed light by providing information about food safety and quality of food handlers towards the vending machine. The study has provided information on practice and the knowledge of the food handlers and increases awareness of the critical practice required to be implemented. This study able to critically improve the current assessment form used by the government and offer a self-assessment tool for industry in order to develop a strategic plan for their food quality and safety program.

Keywords— vending machines; food safety and quality; good hygiene practices; HAS surveys; educational institution

INTRODUCTION

Food safety is a critical public health concern in educational institutions, particularly those that offer vending machine food services. Foodborne infections cause nearly 600 million cases and 420,000 fatalities annually on a global scale, with children accounting for a substantial proportion of these cases because of their increased susceptibility [1]. This risk is particularly significant in educational institutions, where students frequently rely on vending machines and cafeteria services for sustenance and refreshments. The staff in these environments must adhere to proper food handling standards to mitigate contamination risks and preserve a safe environment.

In Malaysia, foodborne illnesses are a significant health issue, with recent reports from the Ministry of Health indicating that up to 30% of foodborne disease outbreaks originate in education settings. Studies show that many food handlers lack adequate training in hygiene practices, with only 73.2% of Malaysian university food handlers reporting attendance at food safety training, leading to inconsistent adherence to best practices [2].

Similarly, studies in other regions underscore the gap between knowledge and actual hygiene practices. Due to the modern lifestyles, demand for fast food processing with good quality from the vending machines has steadily increased especially among Japan, Singapore and Malaysia [3]. Although the demand for the usage of vending machines keeps increasing in the industry, there has been concerned to guarantee buyers about the safety of foods and drinks sold in vending machines.

Food safety remains a critical issue with outbreaks of foodborne illness resulting in substantial costs to individuals, the economy and the food industry [2, 4]. In recent decades there has been a significant increase in the development of food safety in the vending machine industry. Hunter [5] suggested that all vending machine companies should control the quality and safety of their operations, preferably using the same HACCP system. Several studies [6,7] have reported food mishandling as the main cause of foodborne disease and a factor strongly associated with outbreaks. Among the practices of food handlers which are often associated with foodborne outbreaks are inadequate hand hygiene, inadequate hygiene of equipment and utensils, maintenance of food at room temperature [4,6].

Food vending machines

Vending machines, once loaded, are left unattended for long periods of time, which can mean increased microbiological risk. The frequency of cleaning varies depending on the machine type, frequency of use, and location [8, 9]. Inside the machine, there are a few areas where it is possible to accumulate moistened dust which needs to be cleaned to prevent the possibility of microbial growth and the occurrence of dust clumps in beverages [10].

The previous study by [11] showed that hot chocolate sold in vending machines may contain organisms capable of producing toxins that under favorable conditions can induce illness. The problem for consumers is that there is no way to know what is going on microbiology in a machine when they approach it to purchase water. The consumers trust that the machine is delivering what it claims to deliver [12].

It is important to understand the interaction of prevailing food safety beliefs, knowledge and practices of food handlers to minimize foodborne outbreaks [13], which led to the development of the research objectives of this study. Most of the vending machine research has concentrated on their accessibility, product availability, and health, while hygienic-sanitary quality of vending machines has been the subject of limited research [12,13]. Therefore, the aim of this study is to implement a preliminary study assessing the food handlers managing the vending machine on the food safety practices: (i) Identification of current knowledge of food handlers about hygiene practices and attitude related to the food safety of the food produced by doing an interview or examination test, (ii)Identification of practices of food handlers used towards the vending machine by implementing food safety and quality assessment survey to food handler, (iii) to determine the critical elements needed to be trained for the food handler

The significance of this study is providing important information about the criteria of the hygienic-sanitary state of vending machines and the quality and safety of the products. It is also considering the importance of the hygiene knowledge of the intervening food handlers. Moreover, this study will have an impact towards society by reducing food-borne illness among the consumers and increase the awareness of the consumers about the standards of protection that are being applied. This study provides a practical self-assessment tool for the food handlers and food companies on their level on handling food safety to facilitate them to develop a strategic plan for their quality program.

Food Safety and Quality Assessment Tool in Vending Machine

The Hygiene Assessment System (HAS) survey is a tool to assess the adequacy of the vending machine and the food replenishment route. The assessment is in term of the hygienic and sanitary requirements of the legislation in force at the time of baseline (Regulation (EC) 853/2004). The observation protocol was constructed not just with respect based on hygienic-sanitary conditions, additionally considered the operation state of the machines and whether the items consumed held their best organoleptic properties and quality [13].

The hygiene assessment system (HAS) is a risk-based method employed in the UK. It was introduced in 1995, the first year of operation of the meat hygiene system (MHS) with four main purposes which are to measure the hygiene standards in all slaughterhouses and to ensure that there exists a common hygiene standard across the UK [3,14].

In 1998 the government decided to publish the HAS scores to make public the evidence of the joint efforts of

the government and the meat industry to improve and maintain hygiene standards, leaving "no hiding place for operators who damage the reputation of the meat industry" The score considers both legal requirements and the implementation of best practice (i.e. whether the best available methods are in use), giving the highest scores for those operations that use "best practice" [4,15]. The role of the HAS score has been subject of discussion. In June 2003, a requirement for the introduction of controls based on HACCP principles [2] came into force.

Few of the studies detailed the questions used, referring only to the general topics covered. These included high-risk foods, foodborne pathogens, cross-contamination, personal hygiene, temperature control and cleaning[13,15,16]. The study used 4 dimensions, each containing food safety and quality attributes of vending machine as presented in Table 1.

Table 1: Detail of four dimensions with attributes of each dimension

Dimension	Details	Attributes
1	Common Aspects of All Types of Vending Machine	VM1: Machine is labeled with the owner/operator's name and address.
		VM2: Maintains acceptable general external cleanliness for a clean and sanitary appearance.
		VM3: Products not suitable for consumption are removed or reset.
		VM4: Employs effective and healthy methods of cleanliness and hygiene.
		VM5: Uses only authorized products and materials.
2	Replenishing Staff	VRS1: Staff attend regular training.
		VRS2: Staff wear clean, suitable, and proper clothing.
		VRS3: Staff maintain cleanliness and hygiene, such as short and clean fingernails, and sanitize hands before and after handling products.
		VRS4: Staff suffering from or carrying foodborne illnesses (e.g., flu, fever, cuts) are prohibited from handling food.
3	Vehicles and Transportation	VTV1: Vehicles used can maintain appropriate temperature controls.
		VTV2: Vehicles are cleaned and disinfected according to a planned schedule.
		VTV3: Food items are separated from non-food items during transport.
		VTV4: Vehicles are not used for transporting hazardous, toxic, or poisonous items.
4	Location of Machine	VLM1: Adequate space is maintained around and under the vending machine for accessibility and cleaning.

		VLM2: Machines are placed away from contamination sources, such as dustbins, animals, and pests.
		VLM3: The floor beneath and around the machine is easily cleanable or can withstand repeated washing.

METHOD

This study employed structured observation studies, and the source of the data used in this study is primary data. This instrument has been chosen due to the potential it can increase the accuracy of the data collection [17,18]. It allows the interviewer to ensure the respondents understand and answer correctly before the completion of the questionnaire [19]. The questionnaire for food handler was designed into six sections which meet the research objective of the study including demographic characteristic; Common aspect of all types of the vending machine; Food handler/ replenishing staff; Vehicles and Transportation/ Carriage of food or drinks; Location of the machine and Machine-vended water (RO) [20].

No of food handler	Types of Vending Machine	Location
1.	Cold drink vending machine	• Student hall
2.	Cold drink vending machine	• Student hall
3.	Cold Drink Vending Machine Hot & Cold Vending machine (Cup)	• Faculty • Library
4.	Cold Drink Vending Machine	• Faculty
5.	Cold Drink Vending Machine	• Chancellor office
6.	Hot & Cold Drink Vending	• Library
7.	Machine Machine-vended water (RO)	• Student hall
8.	Machine-vended water (RO)	• Student hall
9.	Machine-vended water (RO)	• Student hall
10.	Snack Vending Machine	• Student hall
11.	Snack Vending Machine	• Student hall

The rating scale adopted was same for Section B until Section D, which used five points, Likert scale such as 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always. Meanwhile, in section E and section F respondents are required to answer and rate the questions based on five points of Likert scale that is 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = strongly agree. The questionnaire was adopted from [12] with appropriate adjustments were done with a combination from the previous study with the regulation related in Malaysia to fit with the study to assess the food safety and quality focused on food handlers towards vending machines.

Meanwhile, the structured observational questionnaire was designed based on the previous literature on food safety and quality assessment to clarify a point which is essential in reducing misunderstanding and therefore more effective communication. The researcher contacted Department of Health Selangor, Deputy Director State Health (Food Safety and Quality Section) and Director of Food Safety and Quality Section. Before the

interview was conducted, the researcher provided the background information and briefed the research objectives to provide awareness for the respondents, increase the gaining of relevant information and avoid confusion in the interview sessions. All the information was gathered via voice recording and note taking the main point. The interview was conducted for almost one hour and subsequently improved the development of the criteria, and questionnaire

Purposive sampling involves the researcher determining what sample units are needed and then screening possible participants for eligibility [18]. A purposive sample is chosen based on population features and study goals. This method of sampling is effective when you need to reach a desired sample rapidly and proportionality is not a consideration. Purposive sampling may work when only a few people can be primary data sources due to research design and goals [17].

Before the survey was conducted with the food handlers, a field study was conducted to collect the data by doing the census. Demographic information such as types and quantity of the vending machine, the location and importantly the contact number of the food handlers was collected. Next, we made follow-up calls and confirmed the date, time and place to do the survey. The researcher conducted a structured observation with the respondents based on the questions in the survey [21,22]. The study was conducted in a public university in Selangor. There are 15 food handlers across 13 different vending companies who were selected for this study.

The duration of data collections was two months which started from the end month of September 2023 until the early month of November 2023. A descriptive statistical technique available to analyse the conclusion made on the food handlers food safety practices [4].

RESULTS

Table 2 presents the summary of the key findings of the survey for 15 vending machine food handlers as respondents from 13 different companies.

Table 2: Mean Score for food handler

No of food handler	**Score**			
	1	**2**	**3**	**4**
Food handler 1	3.60	2.25	4.00	3.67
Food handler 2	4.60	4.00	4.00	5.00
Food handler 3	4.00	3.25	5.00	5.00
Food handler 4	4.60	4.00	4.00	5.00
Food handler 5	4.00	3.25	5.00	5.00
Food handler 6	4.40	3.50	4.00	5.00
Food handler 7	4.40	3.50	4.25	4.67
Food handler 9	4.00	3.25	4.25	4.00
Food handler 10	4.40	3.25	4.25	5.00
Food handler 11	4.60	3.50	4.00	5.00
Food handler 12	3.80	3.00	4.00	3.67

Food handler 13	4.00	3.50	5.00	3.67
Food handler 14	4.00	3.00	5.00	5.00
Food handler 15	4.00	3.25	5.00	5.00

Food handler 1,2 handles cold drink (can) vending machine with 2 years average experience and works for a small company A. Food handler 1 has good practice in terms of vehicles and transport with the mean score (4.00) because food handler 1 is aware to maintain the temperature of the vehicle and avoid carrying harmful item. However, the lowest mean score is (2.25) for dimension 2 which is the replenishing food handlers. Neither has attended any training and did not sanitize hands before and after handling the vending machine.

Food handler 3 handles two types of vending machines which are cold drink (can) and cold and hot in cup vending machines in a different location. She has been in the vending business under a small company for almost a year. Food handler 5 achieved the highest mean score (5.00) in dimension 4 which is the location of machines with have space around the machine, away from the source of contamination and floor easily cleanable. Overall, the food handler achieved no significant difference in the mean score as the food handler maintains his good practices in all dimensions.

Food handler 6 is responsible replenish towards cold drink (can) type of vending machine with 2 years of experience and works for a small vending business company. The highest mean score (5.00) recorded in dimension 3 and 4, vehicles and location of machine respectively. The lower mean score (3.25) in dimension 2 due to the food handler does not attend any training and not sanitise hand before and after handling.

Food handler 7 has experienced handling many types of vending machines with such as cold drink vending machine, snack vending machine and reverse osmosis vending machine almost two years. Food handler 7 achieved a higher score (5.00) in dimension 4 which location of machine in excellence condition. While the lower score was recorded in dimension 2 (3.50).

Food handler 8 handles hot and cold in cup vending machine almost 15 years achieved a higher mean score (4.67) in dimension 4 and recorded the lowest mean score (3.50) in dimension 2. The food handler 8 has long been involved in the vending business and he used his experience as a basis for hygiene practice.

Food handler 9 handles cold vending machine almost five years in small company achieved a higher mean score (4.25) in dimension 3. However, the food handler recorded the lower score (3.25) in dimension 2. Food handler 9 handles snack vending machine almost a year in small company achieved a higher score (5.00) in dimension 4 while recorded the lower mean score (3.25) in dimension 2. As the food handler has other main jobs besides doing replenishment, consequently he did not prioritise attending any food safety training. Furthermore, he was also just recently involved in this vending business.

Food handler 10 handles the snack vending machine almost eight years achieved a higher score (5.00) in dimension 4 and recorded the lowest mean score (3.50) in dimension 2. Food handler 10 has its stand which snack vending machine did not need critical care compared to other types of vending machine since all the products already in packaging.

Food handler 11 handles cold drink (can) vending machine for almost two years in small company achieved highest mean score (4.00) in dimension 3 and recorded the lower score (3.00) in dimension 2. Similarly, food handler 11 just uses his common sense related to hygiene while handling the hygiene practice.

Food handler 12 handles reverse osmosis vending machine for almost two years achieved a higher score (5.00) which is attributes focused on the reverse osmosis vending machine. As the machine he bought from the well-establish company which is ‘Dr. S’, reflected optimum conditions of the equipment. The food handler always ensures all the surface contact with water in a safe condition to use. The lower mean score (3.50) in dimension 2.

Food handler 13 and Food handler 14 also handles reverse osmosis vending machines with almost five years

and nine years' experience respectively. Both gain higher scores (5.00) in dimensions 3 and 4, which are attributes focused on reverse osmosis vending machine and location of machine respectively. The location of the machine is in excellent condition with have gap around the machine, away from source of contamination and floor easily cleanable. The lower mean score in dimension 2 with (3.00) and (3.25) respectively.

Finally, food handler 15 handles reverse osmosis vending machine for almost two years. the higher score (5.00) in dimension 3 which is attributes focused on reverse osmosis vending machine. Mostly, the food handler that handles this type of machine is more aware because this type of machine is more critical to handle. It is more easily to contaminate compared to other types of vending machines. The lower mean score (3.25) recorded in dimension 2. The next section will describe the general result of the survey.

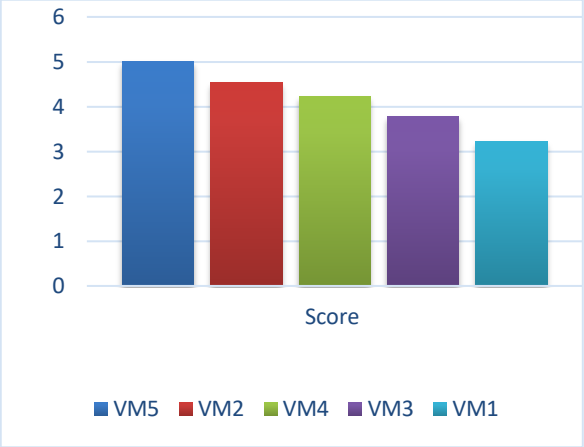

Fig.1. Common Aspects of All Types of Vending Machine

DISCUSSION

Common Aspect of All Types of Vending Machine

Based on Figure 1, the result of VM1 shows 38.46% of the food handler just labeled name and contact numbers on the machine. According to Food hygiene regulation 2009, the name and registered address of the owner is compulsory to be labeled. However, contact numbers are effective communication between consumers, food handlers and the company itself, especially for traceability. The results for VM2 and VM4 variables showed the cleanliness criteria in good condition with 76.92% cleaning and sanitary at least two times a week and 30.77% use effective methods of cleanliness. From the survey, it shows the food handler did very effective cleanliness with a frequency of once each day.

The general external cleanliness refers to the state or quality of being clean or being kept clean and free from dirt. The vending machine shall be rendered clean and sanitary where sanitary meaning of or relating to the conditions that affect hygiene and health, especially clean drinking water. The aim of sanitary is to remove rather than inactivate the microorganisms [16]. Effective cleaning is essential to remove food residue, which can result in the formation of a conditioning film (a covering of organic molecules on the mixing bowl surface) onto which microorganisms may become attached Over bosh and Blanchard".) The importance of visual inspections for preventing the potential risk of foodborne illness. A visual inspection should form part of the cleaning protocol to ensure that visible powder builds up is removed from the surface of the mixing bowl mainly for cup vending machine. Inappropriate cleaning and the development of gross soiling may also result in physical contamination of the product [1].

VM5 obtained an excellence result where 100% achieved the maximum mean score which all vending machines sell authorized products and materials. There is due to all the food handlers receiving or buying their products and material from established and trusted supermarkets or manufacturers. Food and Drugs Administration (FDA) mostly consumer goods and retail will get inspection product to verify that they comply with good manufacturing practices.

Replenishing Staff / Food Handler

Figure 2 shows the result for the VRS1 variable, only 38.46% attended training mainly for reverse osmosis machine food handlers while 61.54% did not receive any training. Food training programs based on theoretical as well as practical activities have been revealed as an important tool in which food handlers can put information into practice 2[3]. For VRS2, it was shown that 69.23% of food handlers use clean, suitable and proper clothing, which for such simple practice, the number is considered quite low. For the VRS3 variable, the result showed 92.31% of food handlers just have short and clean fingernails while 7.69% have short, clean fingernails and wash hands before handling. The result for VRS4 showed 84.62% of food handlers that suffer, or carrier foodborne disease are not allowed to handle food while 15.38% still handling the machine even during flu, fever or cuts.

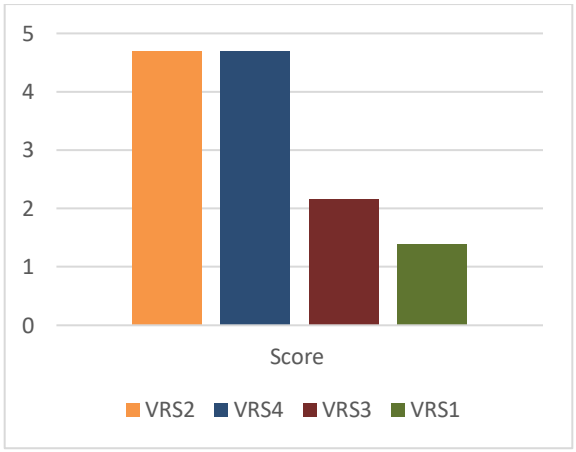

Fig.2. Replenishing Staff/ Food Handler

Vehicles and Transportation/ Carriage of Food

This section examined cold drink vending machines, hot and cold drink (cup) vending machines, and snack vending machines. The reverse osmosis vending machine was not included, as this type draws potable water directly from the nearest pipe, without requiring any vehicle or transportation. Based on Figure 3, which presents findings related to vehicles and transportation, the data for VTV1 showed that all respondents (100%) maintained the required vehicle temperature. For VTV2, 88.89% of food handlers performed basic cleaning on the vehicles without a formal cleaning plan, while 11.11% followed a structured cleaning and disinfection plan. For VTV3, results indicated that 44.44% of food handlers consistently separated food from non-food items during transport, whereas 55.56% did so occasionally, with some respondents using the vehicles for additional purposes beyond product transportation. In VTV4, 100% of food handlers refrained from using vehicles to carry hazardous or toxic substances. Public awareness of food safety risks has grown in recent years [15]. Although consumers generally feel confident about supermarket food safety, they express increased concern when specific food safety issues are highlighted [16].

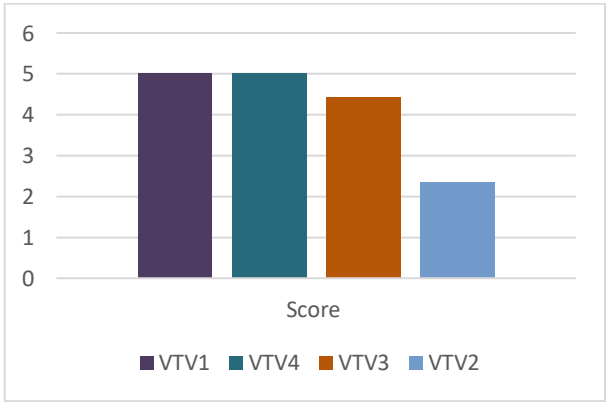

Fig. 3: Vehicles and Transportation/ Carriage of Food

Location of Machine

Figure 4 shows the results of the machine location. The result VLM1 showed 92.31% of the machines have space around and under the machine while 7.69% do not have enough space for the machine. As for VLM2 showed 61.54% of the respondents strongly agreed that the location of the machine is away from sources of contamination while the rest 38.46% have disagreed the machine away from contamination when the vending machine was near with the dustbin and the surrounding not clean. Lastly, VLM3 showed 69.23% the floor was easily cleaned while 30.77% have floor with hard to clean because sometimes there are gaps between the floor and the food handlers not able to withstand repeated washing.

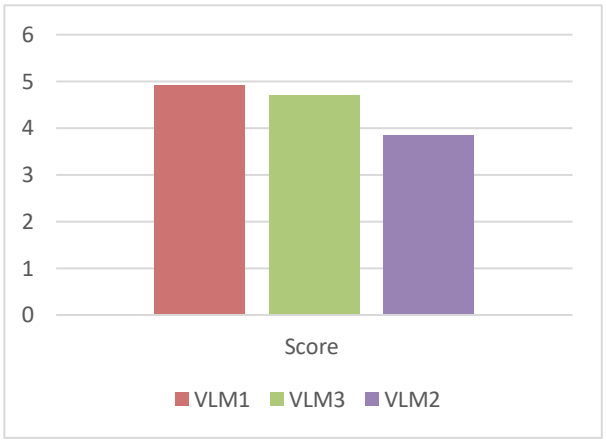

Fig.4: Location of Machine

Machine Vended-Water

Analyzing the details presented in Figure 5 concerning the reverse osmosis or vended-water machines, the results indicated full compliance with all evaluated criteria, achieving a mean score of 5.00. This compliance is attributed to the close oversight by the Ministry of Health Malaysia, which has authority to evaluate these machines and conducts assessments upon receiving complaints. Additionally, reverse osmosis vending machines are required to be licensed before they can operate. According to a prior report by [11,23], contamination was noted in some cases, with the condition of the water machine identified as a key factor influencing contamination levels [24].

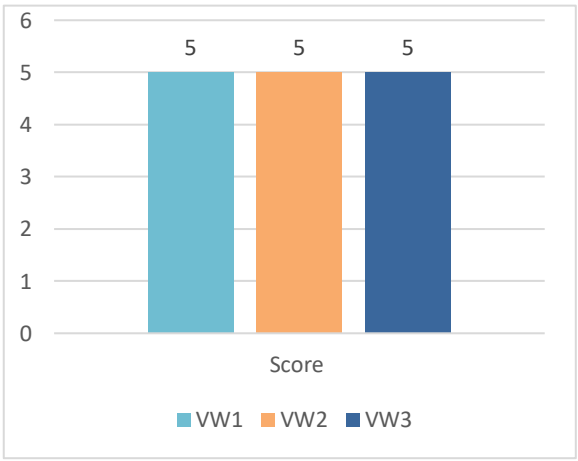

Fig. 5: Machine Vended Water

CONCLUSION

The main objective of this research is to assess the vending machine sanitary and hygiene. Based on the result, it was found that the food handlers were barely aware of the food safety and quality of the vending machine. This is due to most food handlers did not attending any training on Hygiene Awareness and never hearing

about Food Hygiene Regulation. According to the Food Act 1983, food handlers are any person who handles or prepares food, including drink, whether unwrapped or packaged. They must fulfill the Food Hygiene Regulation and require keeping the surrounding area clean. Furthermore, according to Good Hygiene Practice in the (Vending Industry), all food handlers in the vending industry should have a basic understanding of food and personal hygiene before starting work. This could be provided in a short course or training.

Overall the current practices used by the food handler towards the vending machine are good although, the mean for personal hygienic appearance in poor condition when the food handlers mostly did not wash and sanitize hands appropriately after and before handling. Since cleaning drinks vending machines involves handling parts that come into contact with the drink, this requirement applies to those cleaning machines as well as to those handling foods directly. Related to the location, the vending machine must be away from any source of contamination. The food handler of the vending machine in higher education, do find there is no difference if the machine near the dustbin or located in the renovation area despite that the dust and rotten food in the bin have the potential to contaminate the products. Before placing vending machines, the site should be assessed in order to check that it is unlikely to attract insects, particularly ants or cockroaches, to avoid risks of contamination.

The safety and quality parameters used in the vending machine are the cleanliness of the machine and the surrounding, the equipment used, the products, the replenishing staff, the vehicles and transportation and the location of the machine. This study has exposed the practices, and the knowledge of the food handler related to food safety and quality mainly toward the vending machines. Consequently, it will increase awareness of the critical practices required to be implemented by the food handlers toward food safety and quality. The Ministry of Health Malaysia can be benefited of this study where improvement in their assessment tool especially in the vending machine industry can be improved, or the suggested of current digital technologies can be done especially in terms of monitoring the food safety practices [24]

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