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Hazard Identification, Risk Assessment And Control (Hirac) On Physical, Health, And Psychosocial Aspects in the Cafeteria of University X Campus

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ABSTRACT

Campus canteens function as essential social and nutritional spaces within universities but often face overlooked Environmental, Health, and Safety (EHS) challenges. This study applies the Hazard Identification, Risk Assessment, and Control (HIRAC) framework in accordance with ISO 45001:2018 to evaluate occupational and environmental risks in the University X campus canteen. Hazard identification was conducted through direct observation, staff interviews, and document review, followed by a semi-quantitative risk assessment using a likelihood–severity matrix. Nineteen routine activities were analyzed and categorized into physical, health, and psychosocial hazards. The assessment identified cooking processes and reckless food consumption as the highest-risk activities (risk value = 12), primarily due to thermal exposure, smoke accumulation, and potential food contamination. Additional medium-risk hazards included unsafe packaging, poor food storage, and limited emergency access, while psychosocial risks such as stress and overcrowding were rated low to moderate. Overall, health-related hazards contributed most significantly to the canteen's risk profile. The findings indicate that the limited application of HIRAC in canteen operations creates vulnerabilities in everyday food service activities. Strengthening canteen EHS performance requires assigning clear safety accountability, conducting routine risk monitoring, and implementing practical controls such as improved ventilation, allergen labeling, and personal protective equipment. Based on the proposed control measures, the estimated average risk value could potentially decrease from 12 to 4.8, indicating the possible effectiveness of integrating HIRAC into institutional safety management and fostering a more proactive safety culture in educational environments.

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INTRODUCTION

Campus canteens are essential parts of university life. Beyond serving as food outlets, they function as social and economic centers where students, staff, and visitors gather daily. However, behind this dynamic environment lie operational challenges related to hygiene, safety, and mental well-being. In many Indonesian universities, studies have shown that food safety practices, facility hygiene, and occupational health awareness remain inconsistent, often due to limited training and infrastructure (Rahmiwati et al, 2025). These conditions expose both workers and consumers to risks ranging from contamination and physical injury to fatigue and stress. Therefore, applying a structured Environmental, Health, and Safety (EHS) management approach is crucial to ensuring that canteen operations are safe, efficient, and sustainable.

The EHS framework provides a preventive and systematic approach to managing hazards by integrating environmental protection, occupational health, and safety principles into daily

operations. Within this system, the Hazard Identification, Risk Assessment, and Control (HIRAC) method plays a central role. HIRAC enables organizations to identify potential hazards, assess the likelihood and severity of associated risks, and determine appropriate control measures (Jensen et al., 2022). This process supports proactive hazard management and systematic risk reduction while encouraging continuous safety awareness among workers and institutions.

The systematic application of the HIRAC (Hazard Identification, Risk Assessment & Control) framework in educational facilities is essential to ensure the safety of students and staff. By proactively identifying hazards, institutions can prioritize and implement suitable controls, maintain learning continuity, fulfill duty-of-care responsibilities, and foster a safety-oriented culture. Several studies support this approach. Manik et al. (2024) applied HIRAC in an environmental chemistry laboratory at University X to improve operational safety through systematic monitoring and control, while Permana et al. (2025) demonstrated that integrating HIRARC with ISO 45001 standards and safety signage improved safety management in Rubaru 1 Elementary School.

Although previous studies have demonstrated the effectiveness of HIRAC implementation in educational laboratories and school environments, research specifically focusing on campus canteen operations remains limited. Most existing studies emphasize laboratory safety, industrial workplaces, or food hygiene systems such as HACCP, while the integration of occupational, environmental, and psychosocial risks within university food service environments has received less attention. Campus canteens involve unique operational interactions between food preparation activities, dense student movement, sanitation practices, and worker pressure under time constraints, creating complex and interconnected hazards that differ from conventional educational facilities. Therefore, this study contributes by applying the HIRAC framework specifically within a university canteen context to evaluate physical, health, and psychosocial hazards simultaneously, while also proposing practical control measures aligned with ISO 45001:2018 principles.

In the context of a campus canteen, hazards are multifaceted, encompassing physical, health, and psychosocial aspects that interact within a shared workspace. Physical hazards include heat exposure, slippery surfaces, sharp equipment, and repetitive physical activities that may contribute to occupational injuries and reduced work capacity (Smallcombe et al., 2022; Dyreborg et al., 2022). Health hazards involve exposure to biological contaminants, inadequate ventilation, airborne pollutants, and chemical substances from cleaning or sanitation processes that may adversely affect worker health (Lovén et al., 2023; Caskey et al., 2023). Meanwhile, psychosocial hazards refer to workplace conditions such as excessive workload, work pressure, stress, overcrowding, and organizational factors that may negatively influence workers' mental and physical well-being (van Veen et al., 2023; Pindek et al., 2023). These psychosocial factors are particularly important because fatigue and stress may reduce concentration and indirectly increase the likelihood of workplace accidents. However, in canteen operations, the implementation of HIRAC remains limited. Occupational safety responsibilities are often fragmented, staff turnover is high, and safety management tends to focus primarily on food hygiene rather than broader workplace hazards.

The interaction between these categories of hazards makes comprehensive risk management essential. For example, employees working under time pressure may neglect personal safety practices, increasing exposure to burns or slips. Similarly, inadequate ventilation or lighting may contribute simultaneously to health issues and psychological strain. According to Zio (2018), integrated environmental health risk assessments are effective in reducing such cross-cutting risks, particularly in facilities involving young people and vulnerable groups. Therefore, applying HIRAC in campus canteens provides a holistic approach for identifying and managing interconnected risks affecting both workers and food consumers.

At University X, the campus canteen possesses multiple hazard potentials related to physical activities (cutting and cooking processes), health-related risks (food consumption and ingredient handling), and psychosocial factors (student movement, collisions, and emergency access limitations). Evaluating the effectiveness of the HIRAC framework in this setting is necessary to identify and mitigate these hazards systematically. The diversity of canteen users and operational activities—from food preparation to waste handling—makes the canteen a microcosm of complex occupational and environmental interactions. Accordingly, this study aims:

1. To identify potential hazards related to the physical, health, and psychosocial aspects in the University X campus canteen.
2. To assess and classify the level of risk for each hazard using a standardized HIRAC risk matrix based on likelihood and severity.
3. To propose targeted control measures in line with the hierarchy of controls—elimination, substitution, engineering, administrative, and personal protective equipment (PPE)—to minimize or eliminate identified hazards.

Through this research, the study seeks to improve the Environmental, Health, and Safety performance of the campus canteen by providing evidence-based recommendations. Furthermore, it aims to strengthen the role of EHS as an integral component of campus management, promoting a healthier, safer, and more sustainable university environment that supports both academic and community well-being.

METHOD

The HIRAC process in this study was conducted with reference to the principles and requirements outlined in ISO 45001:2018, the international standard for Occupational Health and Safety Management Systems (OHSMS). ISO 45001:2018 provides a framework for managing occupational health and safety risks by integrating proactive hazard identification, risk assessment, worker participation, and continuous improvement (International Organization for Standardization [ISO], 2018). The standard emphasizes systematic management of both physical and psychosocial risks, aligning safety performance with broader organizational goals and compliance requirements.

The use of ISO 45001:2018 in this study is significant for several reasons. First, it ensures that the hazard assessment process adheres to globally recognized best practices and consistent terminology. Second, the standard explicitly incorporates psychosocial factors such as stress, workload, and interpersonal relationships, acknowledging their influence on worker well-being and safety outcomes. Third, it provides a structured methodology that integrates hazard identification and risk control within a Plan-Do-Check-Act (PDCA) cycle, ensuring continuous improvement in workplace safety performance (Fernández-Muñiz et al., 2020).

By aligning the HIRAC procedure with ISO 45001:2018, this study ensures methodological rigor and international comparability. The framework also supports the university's commitment to maintaining a healthy, safe, and sustainable working environment, consistent with institutional policy and broader occupational health management objectives.

Hazard Identification

Hazard identification is a crucial step in occupational health and safety management because it enables organizations to recognize potential sources of harm before incidents occur. According to the International Labour Organization (ILO, 2021), effective hazard identification supports proactive prevention strategies rather than reactive corrective actions. In this study, hazard identification was conducted through three complementary approaches: direct observation, semi-structured interviews, and document review.

Direct observation was conducted within the University X campus canteen over two observation sessions on different days, with each session lasting approximately two hours during peak operational periods. The observation focused on activities, facilities, environmental conditions, worker behavior, and interactions among canteen users. Particular attention was given to food preparation processes, cooking activities, sanitation practices, waste handling, pedestrian movement, emergency access, ventilation conditions, and worker ergonomics. Observation is considered a reliable hazard identification method because it captures real-time operational conditions and situational hazards that may not be fully reflected in written records (Health and Safety Executive, 2013).

The observation scope included canteen workers, food preparation areas, customer activity areas, waste management facilities, and supporting infrastructure within the canteen environment. Physical and health-related hazards were identified directly through field observation of operational activities, environmental conditions, and existing safety practices. Psychosocial hazards were

assessed based on observable workplace conditions, including overcrowding, workload intensity during peak hours, noise exposure, emergency preparedness, workspace limitations, and potential stress-inducing operational factors.

In addition, document review was performed to support and validate observational findings. Reviewed documents included canteen operational procedures, sanitation guidelines, cleaning schedules, waste management procedures, and existing safety-related records. To reduce subjectivity in risk scoring, hazard assessments were conducted using predefined likelihood and severity criteria adapted from Pascarella et al. (2021), ISO 45001:2018, García-Herrero et al. (2012), and Leka and Jain (2010). The use of standardized scoring indicators and reference-based assessment criteria helped ensure consistency and transparency throughout the risk evaluation process. The integration of direct observation and document review strengthened data triangulation and improved the comprehensiveness of hazard identification across physical, health, and psychosocial dimensions within the canteen environment.

Risk Assessment

Following the hazard identification stage, a risk assessment was carried out to evaluate the level of risk associated with each identified hazard. Risk assessment is an integral component of the HIRAC framework that aims to determine both the likelihood and severity of harm arising from workplace hazards (ISO 45001:2018). This process assists in prioritizing hazards that require immediate corrective actions while distinguishing those manageable through routine controls.

To ensure consistency in scoring, likelihood and severity were further evaluated using operational indicator categories adapted from Pascarella et al. (2021). The likelihood value (L) was determined by averaging three indicators:

1. Frequently Event (FE): frequency of the hazard occurring in actual operations.
2. Frequently Observed (FO): frequency at which hazardous conditions were directly observed during assessment.
3. Less Often Event (LE): probability of rare or indirect incidents such as equipment malfunction or unexpected operational failure.

Table 1. Likelihood Categories (Source: Pascarella et al, 2021)

No	Category	Abbreviation	Definition
1	Frequently Event	FE	How many times this hazard happens in real life
2	Frequently Observed	FO	How often it is observed to have the hazard potential
3	Less Often Event	LE	How likely does the rare event happening, such as mechanical failure

The likelihood calculation is expressed as in Equation 1:

$$L = \frac{FE+FO+LE}{3} \quad (1)$$

Meanwhile, severity (S) was evaluated using three consequence indicators:

1. Injury (IN): severity of potential physical injury.
2. Illness (IL): potential to cause illness or health impairment.
3. Fatality/Loss (FL): possibility of fatality, severe loss, or major operational impact.

Table 2. Severity Categories (Source: Pascarella et al, 2021)

No	Category	Abbreviation	Definition
1	Injury	IN	How severe is the physical injury
2	Illness	IL	How possible to cause illness or health issue
3	Fatality/loss	FL	How possible to cause death or fatality

To maintain a conservative and preventive approach, the highest severity score among the three indicators was selected as the final severity value. The severity calculation is expressed as:

$$\boldsymbol{S = \max(IN, IL, FL)} \quad (2)$$

In this study, the risk assessment process employed the Risk Assessment Matrix (RAM) method, which categorizes risks according to the probability of occurrence and the magnitude of impact (Lemmens et al., 2022; Pascarella et al., 2021). Each identified hazard was evaluated based on two main variables: likelihood and severity. The final risk value was calculated using Equation (3):

$$\boldsymbol{Risk\ Value\ (RV) = Likelihood\ (L) \times Severity\ (S)} \quad (3)$$

The resulting scores were then classified into low, medium, or high-risk categories according to the RAM criteria. This approach ensures consistency, transparency, and systematic prioritization of workplace hazards.

LIKELIHOOD	SEVERITY			
	1	2	3	4
2	4	6	8	
3	6	9	12	
4	8	12	16	

Figure 1. Risk Assessment Matrix (Source: QHES Support, 2024)

Table 3. Indicator of Risk Level

Scale	Risk Value	Legend
	(Pascarella et al., 2021)	
1	1 and 2	Neglectable
2	3 and 4	Low
3	6, 8, and 9	Medium
4	12 or 16	High

Table 4. Indicator and Description of Likelihood and Severity

Scale	Risk Value	Likelihood	Severity		
			Physical	Health	Psychosocial
		(Pascarella et al., 2021)	(ISO 45001:2018)	(García-Herrero et al., 2018)	(Leka & Jain., 2010)
1	1 and 2	Rare: Event is unlikely to occur during normal operations	Hardly hurt	Temporary fatigue, mild allergic or irritation reaction	Short-term stress, mild tension, easily managed individually
2	3 and 4	Possible: Event may occur under certain circumstances	Hurt Can be Dealt Privately	Mild illness requiring outpatient care	Noticeable stress, dissatisfaction, or short-term interpersonal conflict

Scale	Risk Value	Likelihood	Severity		
			Physical	Health	Psychosocial
		(Pascarella et al., 2021)	(ISO 45001:2018)	(García-Herrero et al., 2018)	(Leka & Jain., 2010)
3	6, 8, and 9	Likely: Event is expected to occur periodically	Hurt that requires medical treatment	Acute illness requiring medical treatment or short-term hospitalization	Burnout symptoms, anxiety, or persistent mental fatigue affecting work performance
4	12 and 16	Event Occurs Time to Time (30%)	Several serious hurt require hospital handling and death potential	Chronic illness, severe infection, or death potential	Severe psychological distress, depression, or suicidal ideation impacting multiple individuals

Thus, the final risk value for each hazard was obtained through the following sequence:

1. Assign scores for FE, FO, and LE.
2. Calculate the average likelihood value (L).
3. Assign scores for IN, IL, and FL.
4. Select the highest severity value (S).
5. Multiply likelihood and severity to obtain the final risk value (RV) and categorize the level of Risk Value based on Risk Assessment Matrix (RAM) in figure 1.

Control

Once risks were classified, appropriate control measures were determined using the Hierarchy of Controls, a globally recognized framework in occupational health and safety management (NIOSH, 2015; ISO 45001:2018). In the HIRAC process, likelihood represents the probability or frequency of a hazard occurring under existing conditions, while severity indicates the potential magnitude of harm, including physical injury, health impairment, or psychosocial distress.

Control measures were selected according to the hierarchy of effectiveness: elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE). Elimination refers to removing hazards entirely, such as redesigning slippery work areas. Substitution involves replacing hazardous materials or processes with safer alternatives. Engineering controls reduce exposure through physical modifications such as ventilation systems, improved layouts, or barriers. Administrative controls include policies, training, work scheduling, and supervision designed to minimize exposure to hazards. PPE serves as the final layer of protection when other controls cannot sufficiently eliminate risk (NIOSH, 2015).

In this study, the selected controls also considered feasibility and sustainability within the campus canteen setting. Psychosocial hazards such as stress or interpersonal conflict were primarily addressed through administrative measures, including improved communication, clearer task allocation, and workload management. Meanwhile, physical hazards such as slippery floors, burns, and poor ventilation were mitigated through engineering controls and elimination strategies. Integrating the hierarchy of controls ensures that preventive actions remain systematic, practical, and aligned with the ALARP (As Low As Reasonably Practicable) principle, reducing risks to the lowest achievable level (Aven, 2016).

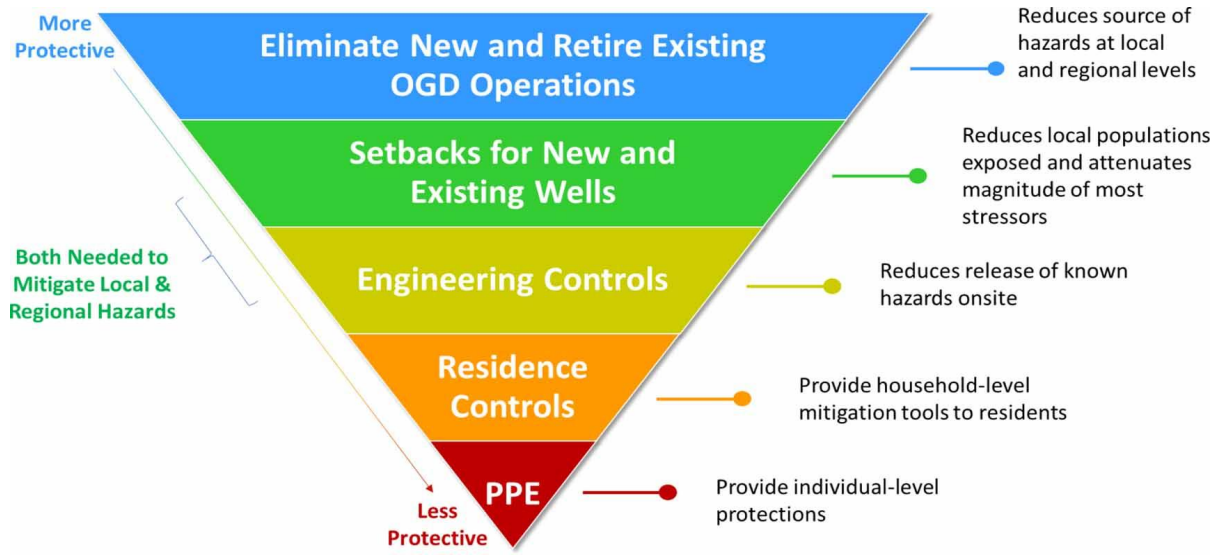

Figure 2. Hierarchy of Control (Source: Deziel *et al*, 2022)

RESULTS

University X Campus Canteen located in the middle between University X class building and convention centre. Consisting of 3 floors with each T-shaped layout, pillared, and iron barrier in second and third floor, University X Campus Canteen also stands right beside a basketball field and gutter area.

This study uses observation and employee interview to collect the data of HIRA at University X First, Second, and Third Floor Campus Canteen, with additional data from accident investigation and record. Observations were done after three visits during the canteen peak hour, which was at 12:00 o'clock in working days. During these observations, conditions related to cooking activity, student access, food sanitation, and physical operations were carefully inspected and interviewed.

A total of 19 activities with 5 classified as physical, 8 as health aspect, and 6 as psychosocial. These activities include cutting, cooking, student queueing, Table and chair comfortability, food storage, food packaging, trash, and disposal of waste from activities. Hazards related to these activities, potential, hazard consequence, and current control were listed in the following Table of Hazard Identification Risk Assessment (HIRA) (Table 5,6, and 7).

The likelihood and severity of each identified hazard were assessed during data collection to calculate risk values. In one of the cases, walking in the canteen has a risk potential of 2 and 3 levels of severity. This is due to the scenario of slippery floor, short-gapped stair design, and low iron barrier with slip and fall frequency of hazard potential, this occurrence is considered seldom and low severity.

With the likelihood and severity, the risk value of 6 was low, as shown in the Table 1. Using this same approach, the risk values of 19 activities were evaluated from three aspects of physical, health, and psychosocial. Some activities have high severity with low frequency or likelihood of occurrence, meanwhile some have medium severity with high likelihood of occurrence.

Therefore, Table 5, 6, and 7 exhibits the HIRA of University X campus canteen for physical, health, and psychosocial aspects to assess each hazard's risk value.

Table 5. HIRA of Physical Aspect

NO	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
1	Walking in the canteen	a. Slippery and narrow floor & staircase b. Low iron stair barrier c. Overload extension cord	Slip & fall	Injuries	a. Regular cleaning for muddy or slippery area b. Design wider staircase and cable disposition	2	2	1	**2**	3	2	3	**3**	**6 (Medium)**
2	Carrying and cooking hot food / beverages	a. Hot food/beverages spilling b. Kitchen overheat steam exposure	Burn and heat exposed	Burn	a. Procedure safety method to bring hot food b. Provide a heat absorbent machine.	2	3	1	**2**	3	2	2	**3**	**6 (Medium)**
3	Gas and electrical usage in the canteen	a. Gas explosion and electrical sparks b. Broken extension cord c. Open flames and burn	Explosion and electrocute	Fatality or death	a. Placing gas and electrical circuit in safe place b. Not using damaged gas or electrical appliances	2	4	1	**2**	4	2	4	**4**	**8 (Medium)**
4	Food preparing activity such as cutting, blendering, moving around the kitchen	a. Mechanical failure that possess sharp contact with body such as blender blade, knife	Cut	Physical cut	a. Proceduremethods of safety in using mechanical in kitchen b. Replace broken tools c. Provide P3K to	2	2	1	**2**	4	1	2	**4**	**8 (Medium)**

NO	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
		b. Sharp-cornered Table, packaging cut, steel cut			take care of early cut injury d. Cover sharp-cornered area									
5	Gathering, moving things, and eating	a. Over-carrying heavy stocks b. Low counter height c. Narrow space to sit down d. Disproportional table size	Body deformation	Deformation	a. Design a trolley area for easier logistic move b. Design an ergonomic sitting area	1	3	1	**2**	4	3	3	**4**	**8 (Medium)**

Table 6. HIRA of Health Aspect

No	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
1	Storaging ingredients for food	Dirty storage with mold and bacteria contamination	Consume spoiled or contaminated food	Digestive health issue	Regular cleaning of food storage, prevent moist location to place food storage	3	4	2	**3**	1	4	3	**4**	**12 (High)**
2	Disposing waste from food, packaging, oil, etc	Waste containing exposure from organic ammonia, biological, chemical especially if trash accumulated	Inhale waste exposure	Respiratory health issue, sickness, nausea	Procedures safe waste disposal and regular waste transportation	2	3	2	**2**	1	4	3	**4**	**8 (Medium)**
3	Consuming	Contaminated or	Consume allergen	Digestive health	Procedure a healthy	4	4	2	**3**	1	4	4	**4**	**12 (High)**

No	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
	food recklessly in the canteen	dirty-processed food served and allergen food consumed due to lack of warning.		issue, allergy trigger	food service and provide an allergen alert sign in every food counter									
4	Gathering around the canteen open area	Canteen located near gutter and bus stop with smell and pollution exposure	Bad smell and bus exhaust	Mild illness and respiratory health issue	Regular cleaning for drainage and relocate food preparation away from roadside	1	2	2	**2**	1	2	2	**2**	**4 (Low)**
5	Cooking activity in the canteen	Kitchen temperature release thermal and smoke that is stuck in the food counter	Heat accumulated and inhaled in body	Sickness, nausea, fever, respiratory health issue	Use proper cooling fans and provide more ventilation in each canteen tenant	3	4	3	**3**	1	4	4	**4**	**12 (High)**
6	Wastewater process during and after cooking activity in the canteen	Exposed pipe conditions can potentially expose and contaminate bacterial, biological substances	Bad smell and contamination	Sickness, nausea, digestive health issue	Regular check-up and maintenance of the pipe, Locate food tenant and storage away from pipe area	2	2	3	**2**	1	4	2	**4**	**8 (Medium)**
7	Packaging the food	Plastic, stereofoam, and box packaging used is hazardous if combined with hot food, releasing toxic chemicals that risk health	Consuming toxic substance	Carcinogenic, sickness, digestive health issue	Invest to eco-friendly and safe food packaging and procedure safety in packaging hot food	3	4	2	**3**	4	3	3	**4**	**12 (High)**
8	Colouring and seasoning the food in the canteen	Using food agents such as synthetic colouring, potentially irritate, trigger allergy, and growing sickness	Consuming unhealthy food agents	Carcinogenic, sickness, digestive health issue	Limit the use of synthetic food agents and prioritize natural alternatives	3	4	1	**3**	3	3	3	**3**	**9 (Medium)**

Table 7. HIRA of Psychosocial Aspect

NO	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
1	Kitchen and study activities in the canteen area	Cooking operation, student noise, name calling that all happen repeatedly and simultaneously	Loud noise simultaneously	Stress, dissatisfaction, overstimulation, burnout	Design a special comfort place in canteen to eat or gathering and expand larger canteen area to prevent closeness between food tenant and student place to gather	4	4	2	**3**	1	2	1	**2**	**6 (Medium)**
2	Walking in the canteen	Congested space due to overcrowding and irregular moving direction	Movement difficulties and stressful queue	Stress, dissatisfaction, overstimulation, burnout	Set max capacity, expand the canteen's access, create a personalized walking access for going and out the canteen, and expand canteen area with ergonomic design of Table and chair	4	4	2	**3**	1	2	2	**2**	**6 (Medium)**
3	Gathering around in the canteen area	Uncomfortable chairs and Table size, oily Table, low and poor-designed rooftop, low counter height, and dirty chair	Bad posture and smelly Table	Stress due to discomfort and dissatisfaction	Design a seat that is half-tall of the Table or design personal chair with backrest	4	4	1	**3**	1	2	2	**2**	**6 (Medium)**
4	Sanitation employee working	Stress, exhaustion, and overburdened mental due to peak hours activities that overburden their working capability	Overworking	Stress, lowered performance, overstimulation, burnout	Operate more worker in shift schedule, regulate peak hours activity with more workers in shift, procedure the employees and students to keep area clean	2	3	1	**2**	1	3	2	**3**	**6 (Medium)**
5	Getting an	Lack of emergency	Lack of access	Mistrust, short-	Provide emergency	3	4	2	**3**	2	2	4	**4**	**12 (High)**

NO	Activity	Hazard Scenario	Potential	Consequences	Control	Initial Assessment								Risk Value
						Likelihood Average				Severity Maximum				
						FE	FO	LE	**L**	IN	IL	FL	**S**	
	emergency condition in the canteen due to disaster or abrupt condition	access, tools and training, along with small space causing lack emergency mitigation for disaster, such as flood or lack of emergency control during sudden open flames	and action	term stress	access or emergency flow direction in canteen, procedure emergency training or written procedure with proper tools									
6	Canteen overcrowding stress and condition	Absence of security during peak hours that overcrowds the canteen area	potential fight, stealing, or conflict without protection	Stress and mistrust, interpersonal conflict	Schedule a security during canteen peak hours and security for regular patrol	2	4	2	**3**	1	1	1	**1**	**3 (Low)**

According to Tables 5, 6, and 7, the HIRA of campus canteen activity, the higher risk value of physical activity is gas and electrical use with 8 risk value. While the highest health aspect with 12 risk value is cooking and consuming food recklessly activity, and psychosocial aspect risk value is 12 for emergency activity. Most of the high-risk value activity is in the health aspect, with 4 out 8 activities classified as 12 risk values. Therefore, the priority sorting will prioritize 12 risk values from the health aspect. After the risk assessment, Table 8 serves as priority sorting of HIRA based on the highest risk value of hazards.

Table 8. Priority Sorting of HIRA

NO	Activity	Risk Value	Aspect	Current Control
1	Cooking activity in the canteen	12	Health	Use proper cooling fans and provide more ventilation in each canteen tenant
2	Consuming food recklessly in the canteen	12	Health	Procedure a healthy food service and provide an allergen alert sign in every food counter
3	Storaging ingredients for food	12	Health	Regular cleaning of food storage, prevent moist location to place food storage
4	Packaging the food	12	Health	Invest to eco-friendly and safe food packaging and procedure safety in packaging hot food
5	Getting an emergency condition in the canteen due to disaster or abrupt condition	12	Psychosocial	Provide emergency access or emergency flow direction in canteen, procedure emergency training or written procedure with proper tools

Among the three assessed aspects, as presented in Table 8, cooking activities, reckless food consumption, improper food storage, hazardous food packaging, and emergency conditions were identified as the highest-priority hazards, each obtaining a risk value of 12 categorized as High risk. Four out of the five highest-priority hazards originated from the health aspect, indicating that food safety, ventilation, contamination control, and packaging practices represent the most critical Environmental, Health, and Safety (EHS) concerns within the campus canteen environment. In particular, cooking activities generate thermal exposure and smoke accumulation that may negatively affect respiratory health, while reckless food consumption may expose users to allergens or contaminated food due to inadequate hygiene practices and insufficient allergen information. These findings indicate that both employee operations and student activities are vulnerable to significant health risks when appropriate controls are not adequately implemented.

The Priority Sorting Table was developed to identify hazard scenarios requiring the most urgent corrective actions based on their risk values and potential operational impact. Hazards with higher risk values were prioritized because they represent greater potential consequences for worker safety, consumer health, and operational continuity. This prioritization process supports systematic allocation of safety resources toward the most critical hazards within the canteen environment.

To strengthen the prioritization analysis, the Pareto principle was applied to identify the “vital few” hazards contributing to the majority of cumulative risk exposure. Based on the Pareto analysis, the first several high-risk activities accounted for most of the total cumulative risk within the canteen operations, demonstrating that a relatively small number of hazards contributed disproportionately to overall safety concerns. According to the 80/20 principle, approximately 80% of operational impacts are often caused by around 20% of the root causes (Spasojević-Brkić et al., 2022). Therefore, prioritizing controls for cooking activities, food contamination risks, storage sanitation, packaging safety, and emergency preparedness is expected to provide the most substantial improvement in the canteen’s Environmental, Health, and Safety performance.

Following hazard identification and risk assessment, control and mitigation strategies were developed to reduce the identified risks systematically. The proposed controls presented in Table 9 were arranged based on the priority sorting results and categorized according to the Hierarchy of Controls approach. These measures aim to minimize risk levels and improve safety conditions for both students and employees operating within the campus canteen environment.

Table 9. Control Plan of Campus Canteen HIRA

No	Hazard Scenario	Current Control	Current Risk Value	Elimination	Substitution	Engineering Control	Administrative Control	PPE	Expected Risk		
									L	S	Risk Value
1	Kitchen heat and smoke that is stuck in the food counter	Use proper cooling fans and provide more ventilation in each canteen tenant	12	-	Replace gas stove with induction stove	Install exhaust fan and ventilation ducts	Schedule maintenance and air quality monitoring	Mask and heat-resistant gloves	3	**2**	**6 (Medium)**
2	Dirty-processed and allergen food consumed due to lack of warning	Procedure a healthy food service and provide an allergen alert sign in every food counter	12	-	Use verified allergen-free ingredients	Provide separate utensils and storage for allergen food	Conduct hygiene training and implement food safety SOP	Gloves, apron, and mask	3	**2**	**6 (Medium)**
3	Plastic, stereofoam, and box packaging used for with hot food	Invest to safe food packaging and procedure safety in packaging hot food	12	-	Substitute with PP5 packaging	Procedure safe food packaging	Supplier audit and procurement policy for safe package	Gloves	2	**2**	**4 (Low)**
4	Dirty storage with mold and bacteria contamination	Regular cleaning of food storage, prevent moist	12	-	Replace wooden shelves with	Install ventilation and	Schedule routine cleaning and inspection	Gloves and mask	2	**2**	**4 (Low)**

No	Hazard Scenario	Current Control	Current Risk Value	Elimination	Substitution	Engineering Control	Administrative Control	PPE	Expected Risk		
									L	S	Risk Value
		location to place food storage			stainless steel	humidity control					
5	Lack of emergency access, tools and training, along with small space causing lack emergency mitigation	Provide emergency access or emergency procedure and training with proper tools	12	Remove physical obstacles blocking exits	Substitute manual alarms with automatic system	Install clear emergency routes and signage	Conduct periodic drills and staff training	Fire Extinguisher	2	**2**	**4 (Low)**
AVERAGE						**12**					**4.8**
STANDARD DEVIATION						**0**					**1.09**

The risk control Table serves to summarize the mitigation strategies proposed to address identified hazards. It provides a clear overview of the control measures, their priority levels, and the type of actions required to reduce risks effectively. This Table helps ensure that all necessary precautions are systematically implemented to maintain a safe and controlled environment during the experimental process. For example, the first hazard scenario of the control plan is cooking activity in the canteen that accumulates thermal. The existing control of this scenario is to use proper cooling fans and provide more ventilation in each canteen tenant, the elimination of this scenario is relocate heat sources away from counter, the substitution is replace gas stove with induction stove, the engineering control is by installing exhaust fan and ventilation ducts, the administrative control is to schedule maintenance and air monitoring, and the PPE is by wearing mask and heat-resistant gloves.

In figure 3 below, a chart showing the existing average risk value and improved average risk value expects that applied current control can reduce the amount of average risk value from 12 to average risk value of 4.8.

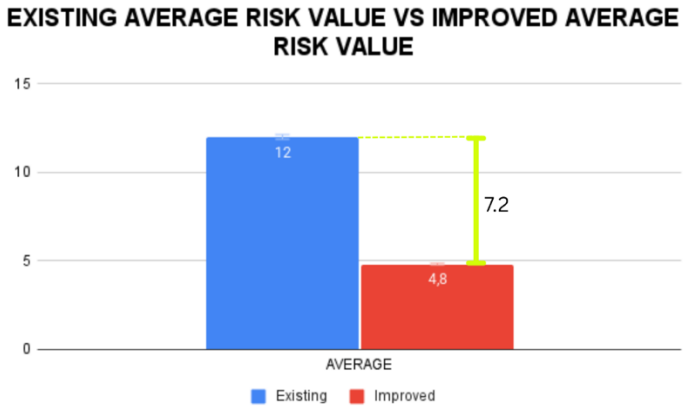

Figure 3. Existing Average Risk Value Compared to Improved Average Risk Value

DISCUSSION

The findings of this study indicate that health-related hazards represent the most dominant Environmental, Health, and Safety (EHS) concern within the University X campus canteen environment. Activities related to cooking processes, food consumption, ingredient storage, and food packaging consistently obtained the highest risk values, suggesting that food-service operations expose both workers and consumers to continuous contamination, thermal, and sanitation-related risks. The dominance of health-related hazards may be influenced by the high intensity of daily canteen activities, limited ventilation, close interaction between food preparation and consumer areas, as well as inadequate control of food sanitation and allergen management during peak operational hours.

These findings are consistent with previous studies on university canteen hygiene and occupational safety. Luu-Thi and Michiels (2021) reported that ready-to-eat foods in university canteens in Hanoi contained significant microbiological contamination, including *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus*, indicating that sanitation and food-handling practices remain major concerns in educational food-service facilities. Similarly, Giwa et al. (2021) found that contaminated preparation surfaces, utensils, and food handlers contributed significantly to bacterial contamination risks in university cafeterias. In Indonesia, Nofita and Mustakim (2023) observed that several campus canteens did not fully comply with sanitation and hygiene standards, particularly in food handling, serving procedures, and facility cleanliness. These studies support the present findings, where contamination-related hazards and inadequate environmental controls became the most critical risks identified through the HIRAC assessment.

In addition to food sanitation concerns, this study also identified psychosocial and operational hazards such as overcrowding stress, emergency access limitations, and employee fatigue during

peak hours. This finding expands previous canteen safety studies that primarily focused on microbiological contamination and hygiene quality alone. By integrating physical, health, and psychosocial hazards simultaneously within the ISO 45001:2018-based HIRAC framework, this study demonstrates that campus canteen safety involves interconnected occupational and environmental factors affecting both operational workers and campus communities. Therefore, risk management within university canteens should not only prioritize food hygiene compliance but also consider ventilation quality, ergonomic design, emergency preparedness, and psychosocial working conditions as part of an integrated EHS management system.

Limitation of the Result

This study has several limitations that should be considered when interpreting the findings.

1. The hazard identification and risk assessment were conducted based on observational visits during peak operational hours within a limited study period, which may not fully represent all operational conditions of the campus canteen.
2. The assessment relied primarily on direct observation, interviews, and institutional records, which may contain subjective interpretation and observer bias during hazard evaluation and scoring.
3. The proposed control measures were developed based on the HIRAC framework and hierarchy of controls but were not implemented and reassessed within the scope of this study.

Therefore, the expected reduction in risk values represents a projected outcome rather than a directly verified intervention result. Future studies are recommended to conduct longitudinal monitoring and post-implementation evaluation to validate the effectiveness of the proposed control measures under actual operational conditions.

CONCLUSIONS

By applying the Hazard Identification, Risk Assessment, and Control (HIRAC) framework, hazards within the University X campus canteen were systematically identified across physical, health, and psychosocial aspects. A total of 19 activities were assessed, consisting of 5 physical, 8 health-related, and 6 psychosocial activities. The findings showed that health-related hazards were the dominant risks, particularly in cooking activities, food consumption, food storage, and packaging practices, with several activities categorized as high risk.

Based on the assessment results, control measures were proposed using the hierarchy of controls approach, including elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE). The proposed controls indicate the potential to reduce operational risk levels if implemented consistently. However, the expected reduction of average risk values from 12 to 4.8 represents a projected post-control outcome and was not validated through direct implementation within this study.

Overall, this study highlights the importance of integrating HIRAC and ISO 45001:2018 principles into campus canteen management to improve Environmental, Health, and Safety (EHS) performance for both students and employees. Future studies are recommended to evaluate the effectiveness of implemented controls through post-intervention monitoring and reassessment.

AUTHOR CONTRIBUTION STATEMENT

YB contributed to the conceptualization of the study, supervision, methodology validation, and final manuscript review. AS contributed to data collection, hazard identification observation, and literature review. JA contributed to risk assessment analysis, HIRA table preparation, and data interpretation. LA contributed to methodology development, figure and table preparation, and manuscript editing. MA contributed to discussion development, comparative literature analysis, manuscript writing, and formatting preparation. All authors contributed to the review and approval of the final manuscript.

AI DISCLOSURE STATEMENT

The author used Claude AI during the preparation of this work for grammar and structure refining. After using the tool/service, the author thoroughly reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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