

RESEARCH ARTICLE

Safety and Quality Self-Evaluation Tool for Food Industry

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ABSTRACT - Food safety and hygiene are crucially important in any baking industry. The absence of knowledge, attitude, and good practices among food workers has led to concerns over food safety in the modern era. The food industry faces increasing regulatory pressures and consumer demands for safe, high-quality products. To reduce the cases and issues in the food industry related to food contamination in the bakery industry, the evaluation will help determine the relationship between knowledge and good hygiene practices in food handling and the level of hygiene evaluation in food industry quality in food handling processes. The primary objective encompassed constructing a robust framework grounded in established legislation and developing a self-evaluation tool. Two experts in food safety participated in the content validation of the safety and quality self-evaluation tool. The scale-level content validity index (CVI) based on the average method is 0.97. These indicate that most of the items in the developed safety and quality self-evaluation tool meet the satisfaction levels of both experts. A case study was conducted to gain feedback using the System Usability Scale (SUS). The findings from the usability study indicated a marginal acceptability of the tool with an overall average SUS score of 66.25%.

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1.0 INTRODUCTION

Food manufacturing is crucial in ensuring that food products are safe for ingestion by people. This is accomplished through several strategies, including sanitation, hygiene, and quality control. Food safety and hygiene are crucially important in any baking industry, as they contain certain features different from other food manufacturing industries [1]. The Baking Industry is a part of the manufacturing industry that produces a large selection of baked foods. These consist of baked goods such as pies, bread, cakes, pastries, cookies, and biscuits. The baking industry includes large-scale commercial production and artisanal bakeries that operate on a smaller scale. Additionally, various risks might be created during the manufacturing procedure through various processing processes. Since employees are the first line of defense in guaranteeing food safety, they need to be well-prepared in many terms, and have a good outlook on it, and practice properly. Through appropriate training, one can improve one's knowledge, attitude, and practices. The creation of well-organized tools and training programs, as well as scientific and technical expertise, are all necessary for improving food safety. An ideal framework for implementing a food safety management system (FSMS) is ISO 22000:2018. Since the initial guideline was released more than ten years ago, there have been substantial changes in how food is grown, transported, made, and consumed. The revised standard considers these modifications and intends to assist organizations in lowering food safety risks. The revised standard edition also adds the Plan-Do-Check-Act (PDCA) cycle and risk-based thinking, making ISO 22000 and the associated FSMS easier to connect with other ISO management systems. An organization's exposure to risk can be decreased. Safety can be improved by combining PDCA and risk-based thinking to manage business risk with HACCP to identify, avoid, and control food safety concerns. Due to the increasing importance of food safety, ISO 22000 certification is recognized and widely used in Malaysia, where the food industry needs to comply with local legal requirements [2-3].

The food industry faces increasing regulatory pressures and consumer demands for safe, high-quality products. To reduce the cases and issues in the food industry related to food contamination in the bakery industry, the evaluation will help determine the relationship between knowledge and good hygiene practices in food handling and the level of hygiene evaluation in the food industry. Development of the self-evaluation tools in this study enables to assist all businesses according to food regulations and acts by ISO 22000, including the Food Safety and Quality of Food Hygiene Act.

This study highlights the shortcomings of the self-evaluation tool that leads to poor hygienic and safety programs. Food workers must be evaluated through food safety knowledge, attitude, and self-reported practices related to hygiene while handling food, as this needs to be calculated for the level of hygiene in the bakery industries. Therefore, the self-evaluation tool will cover a wide range of hygiene-related topics, including food safety management systems, Hazard Analysis Critical Control Point (HACCP) principles, facility design and maintenance, sanitation practices, and employee training has been developed in this study.

2.0 METHODS AND MATERIAL

Figure 1 shows the flow of this study. Starting from framework and tool development, validation, and case study, leading to robust findings and practical recommendations. Microsoft Excel is applied in the development of the tools in this study. The research framework for the study focuses on the requirements of a safety and quality self-evaluation tool for the food industry. It provides a structured approach to guide the research process. This involves identifying the key domains and sub-domains to be assessed, defining the evaluation criteria, and developing the scoring system or metrics to quantify the results. The tool should be user-friendly, comprehensive, and aligned with industry standards and regulatory requirements. The research framework provides a systematic and structured approach to guide the study on developing a safety and quality self-evaluation tool for the food industry.

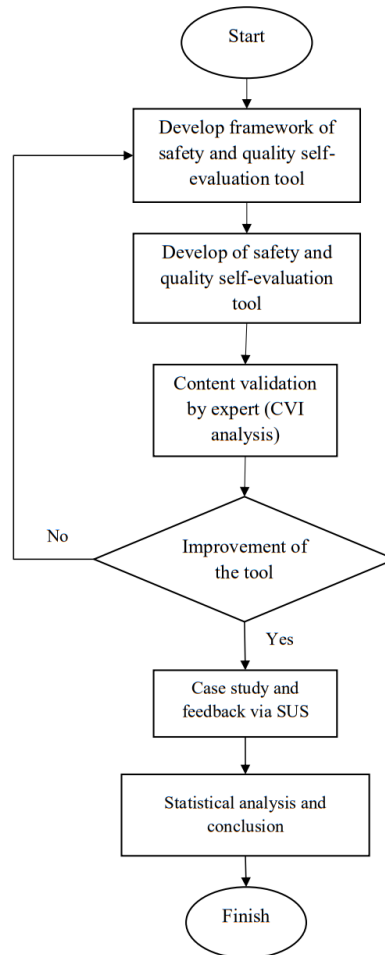


Figure 1. Research framework of safety and quality self-evaluation tool

2.1 Content Validation by Experts

The metric used the most frequently in quantitative evaluation is the content validity index (CVI). I-CVI and S-CVI are the two different types of CVI. I-CVI can be modified using a technique to account for chance agreement. Scale level CVI is calculated using two distinct formulas: $S-CVI/UA$ and $S-CVI/Ave$. To produce reliable results, a test, survey, or measurement technique's content must include all crucial facets of the subject it seeks to evaluate [4]. The items for quality and safety self-evaluation have been validated by using the CVI methodology to ensure the relevance of this tool to food industry employees. Two experts have been involved in validating the indicators of this tool and making a judgment on the items of the tool. Two validation forms undergo the content validation calculations to gain the relevance of each item.

2.2 Case Study and System Usability Scale (SUS)

Experts from related fields did content validation with case studies to test the feasibility of the tool. Using a Likert scale, the SUS survey consists of ten standardize statements. Each question can be answered with a number between 1 and 5, allowing the user to determine the degree of agreement with the statement. A simple equation must then be applied to the number to interpret the SUS data. You must deduct one from the odd statements. To compute the data, the answers to questions 1, 3, 5, 7, and 9 will be subtracted by 1. In the meantime, you must deduct 5 from the solutions for the even

statements 2, 4, 6, 8, and 10. You must add up all these values and then multiply the result by 2.5 [5] Then, the SUS score will be computed to the SUS score mean and will be interpreted using SUS score interpretation.

Table 1. SUS score interpretation [5]

SUS Score	Grade	Adjective rating
>80.3	A	Excellent
68 - 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
< 51	F	Awful

3.0 RESULTS AND DISCUSSION

3.1 Construction of Safety and Quality Self-Evaluation Tool

This safety and quality self-evaluation tool is based on the ISO22000 Food Safety Management System, Food Hygiene Regulation, Food Act and Regulation, and HACCP documentation. As highlighted before, this tool will focus only on the food industry's hygiene. This tool is distributed into three checklist sections: work environment, food handler, and work organization. In the work environment section, all checklists comprised all sectors in the food manufacturing process.

This tool encourages safe and wholesome hygiene practices throughout food processing by self-evaluating personnel hygiene, workspace, and the company's superior action in emphasizing hygiene in the industry. Figure 2 presents the framework for developing the tool for grading the degree of hygiene in the food company. It is more comprehensive and convenient for self-assessment and to spread awareness among employers, employees, and customers. At the same time, focusing on the food manufacturing industry, this tool is also suitable for use in small premises, food stores, or restaurants. This safety and quality self-evaluation tool indeed can be used by various sections of occupation in the food industry; they were not restricted only to upper management.

The development of safety and quality tools began with the main page that displays the personal details, name, employee ID, occupation or position, department, and company name. This step is needed to ensure no fraud and to trace the occupations that carry out this self-evaluation. Once saved and the print button is clicked on after the self-assessment is performed, all the keys in personal details will be shown at the end of the results. When the user fills in the date and details required, the tool starts to operate after clicking the 'Start' button to proceed to the checklist section. For all the following three sections, this self-evaluation tool checklist provides an answer with 'yes' or 'no' options.

This tool is a helper for food quality officers or safety and health officers in the food industry as they can relate their previous HACCP of the company document with this tool remark at the end of the self-assessment. HACCP is restricted only to upper management as they have full authorization for their responsibilities. However, this safety and quality self-evaluation tool also provided the laws and regulations in Malaysia, which are the Food Act 1983, Food Regulations 1985, and Food Hygiene Regulations 2009, that can be used as references for the user. The flow chart then continues with sheet two of self-evaluation, which starts with personnel hygiene. This section is required to be filled in by themselves and not responded to by other people. The results of the personnel hygiene checklist will show the level of understanding of hygiene among workers. Another is that workers' knowledge and attitudes toward applying good hygiene practices will be evaluated. In this section, any allergies or illnesses from workers can be reported and recorded, as these matters can affect food processing.

Then, this self-evaluation will proceed to the work environment section. In this section, three matters must be evaluated: raw materials handling, production of food and packaging, and product delivery. Raw materials handling involves the process of food preparation and storage protection. In the food production section, the utensils and equipment, water, sewage, baking or cooking, and workspace lighting and ventilation throughout the production process will be evaluated by this tool to ensure good hygiene practices. Then, the tool evaluates the last food processing, which is pest control, and refuses. This section will evaluate whether the food industry uses proper garbage disposal after processing food. Move to another section from the previous flow chart that discusses the work organization of the food industry. This section will show how upper management handles hygiene, safety, and quality in employers, employees, and customers, as this is also a part of the prevention of any accidents. According to the flow chart, there were two indicators: management efforts and work facilities that are provided for employees, which will be evaluated. The management responsibility of workers and customers will be evaluated to prove the initiative was reasonable and conducted.

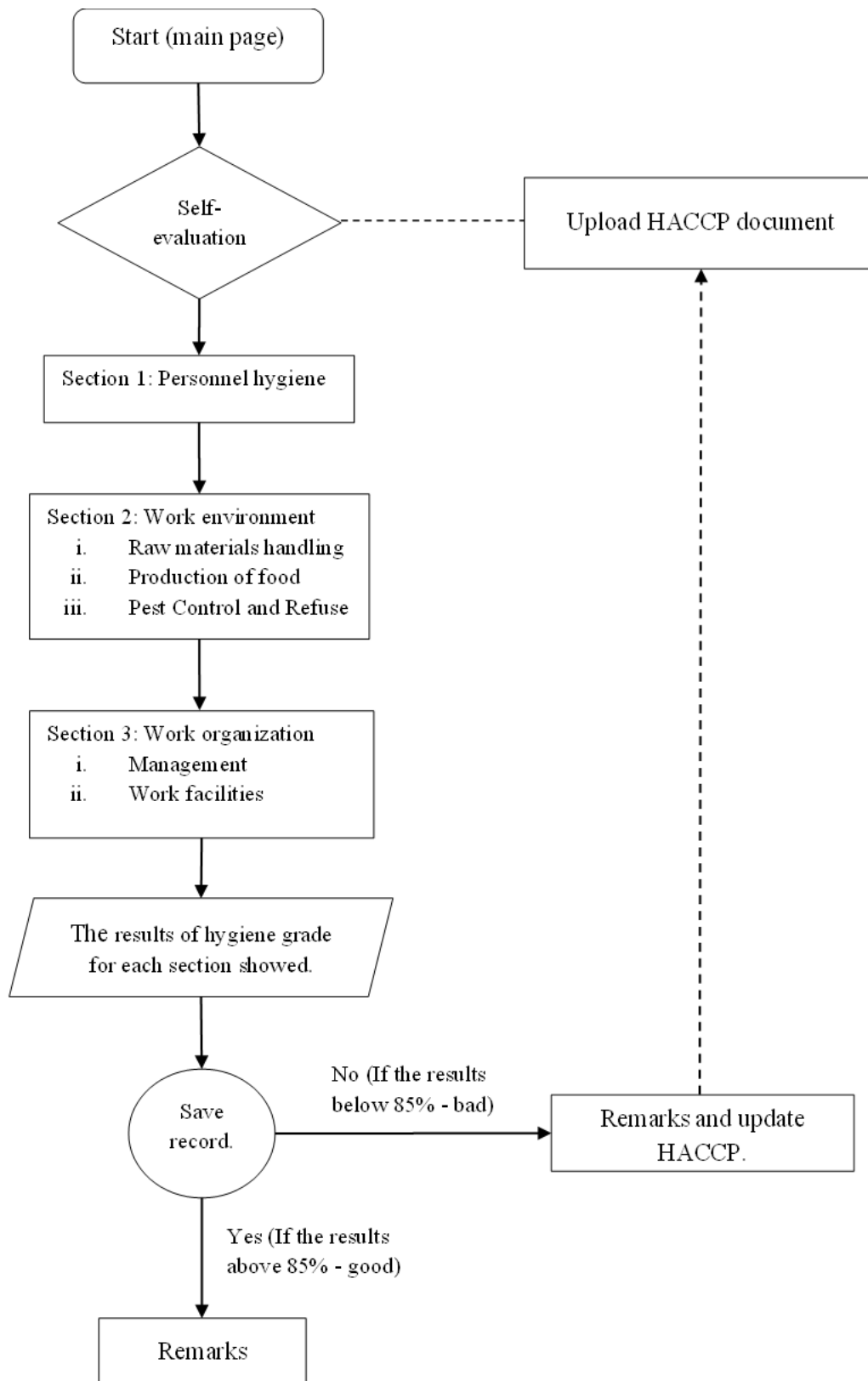


Figure 2. Construction framework of Safety and Quality Self-Evaluation tool

Finally, the results of hygiene grades for each section are shown along with personal details as further documentation, especially for upper management, such as the food quality officer or safety and health officer. A good safety and quality self-evaluation result will display a mark above 85% from the 'yes' answer, then it will prove that the food industry is safe and clean to operate. However, if the results are below 85%, the upper management will get a remark, which is a warning that they need to update HACCP and solve the problem as soon as possible. Low marks of safety and quality self-evaluation can eventually affect food industry operation, but still, the management can detect which section should be improved. It is more effective and systematic as it focuses on the section that needs to be managed from any accidents

occurring. This self-evaluation tool can be used at short intervals to get a quick evaluation of the safety and quality of the food industry.

3.2 Content Validation by Experts

To ascertain whether the items cover the content domain sufficiently, experts or stakeholders must methodically and thoroughly examine the tool's content. For this tool, a content validation system has been constructed by experts from the safety and quality major and from the food industry. The experts have over seven years of experience in the food industry and hold the assistant safety manager and senior quality control executive positions, respectively. All three sections, with a total of 93 items from various sources related to food hygiene, were listed in the content validation form with a relevance scale. All the items specified in the content validation form have been divided into three sections: work environment, work organization, and personnel hygiene, as they pertain to the food sector.

The experts will validate items by identifying whether the items are appropriate and suitable for the checklist system in the tool. Other than that, all items were validated by ensuring they were related to the project domain. Before assigning a score for each item, the experts are asked to evaluate the domain and its contents critically. Expert input is highly encouraged to enhance the item's relevance to the chosen topic through written or vocal comments. The proportion relevance of Expert 1 is 0.94, while Expert 2 is 1.00. I-CVI (item-level content validity index) of these 93 items is mostly 1, while only 6 out of 93 items were 0.5. S-CVI/UA, a scale-level content validity index based on the universal agreement method, is 0.94, the average of UA scores across all items. Then, S-CVI/Ave (scale-level content validity index based on the average method) is 0.97. The number of two review panel experts can accept at least 0.80 CVI values. Therefore, it means all the CVI value items and CVI value for scale is greater than 0.80 [4]. These indicate that most of the items in the developed safety and quality self-evaluation tool meet the satisfaction levels of both experts. Assessments are acceptable in terms of their overall validity. The computation above leads us to the conclusion that the content validity of indicators has reached a reasonable level since I-CVI, S-CVI/Ave, and S-CVI/UA all satisfy the required limit.

3.3 Safety and Quality Self-Evaluation Tool for the Food Industry

Safety and Quality Self-Evaluation Tool Development in the food industry has been developed using Excel with VBA and a macro system. Microsoft Office applications like Excel have Visual Basic for Applications (VBA) embedded. It offers extensive tools for managing, debugging, and developing modules, mainly when the button has been used in VBA and when changing the sheet name. Macros were linked to buttons, shapes, sheet names, and other objects in Excel. This tool is an Excel checklist system containing acts and regulations, three sections of the checklist, and remarks of this system results as future references.

It will start from the Excel workbook given and need to be saved as an Excel Macro-Enabled Workbook to ensure the macro and VBA system work (Figure 3 and Figure 4). The 'Main Page' will display one of the tools on the homepage with the title Development of Safety and Quality Self-Evaluation Tool in the Food Industry. All data requirements are accessible to all users to be edited. The worksheet is protected, and you can only edit the requirements section. This 'Main Page' sheet uses only two VBA code buttons to proceed directly to the 'Start' and 'Act and Regulation' sheets. The main button, 'Start' on the right sheet will proceed to the second sheet of the tool.

Meanwhile, the 'Act and Regulation' button will go directly to sheet eight of the tool, displaying three acts and regulations. From Figure 3, by selecting the text option from the insert menu, the act and regulation file will first be converted to an embedded PDF file. Choose "object" from the text dropdown menu, then select "create from file" on the right. Click Insert after browsing the PDF file and checking the display as an icon box. The linked PDF file includes Icons from the default PDF reader.

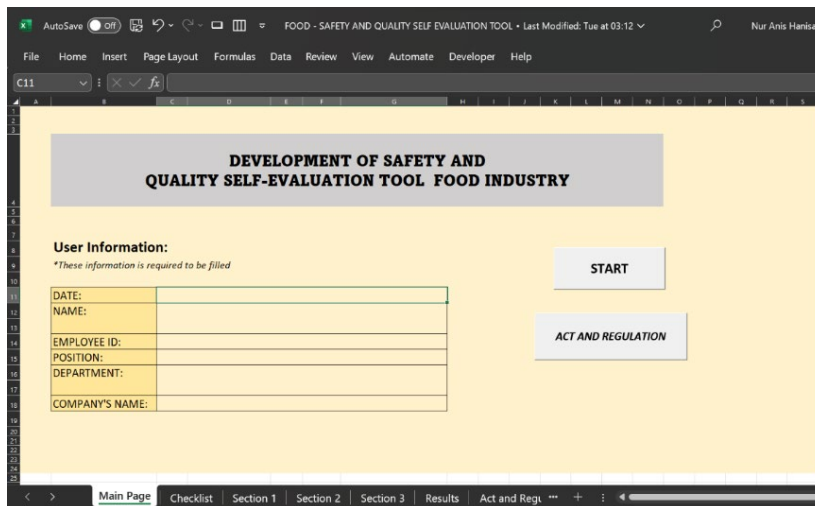


Figure 3. Display of Main Page

The total database of items validated and sorted for this food safety and quality tool is 91. According to one of the experts, only 2 out of 6 validated items that need to be more relevant are clearly stated to be included in the tool. At the same time, the other four can still be used by editing the items to make them the correct items. The four updated items remained in the correct section as they were. All items have been divided into three sections according to their focuses and criteria related, and all three sections were on different pages of the sheet. Then, the user will go through the checklist tool by clicking all three button sections individually. If a user needs to change their personnel details information from the previous page, they can click on the arrow button on the right below the sheet to return to the main page sheet.

Then, after the user clicks on the first button of section 1, 'Personnel Hygiene,', on the upper left side sheet, they will go to the page of sheet 3, 'Section 1,', which will display all 14 items for the user to evaluate (Figure 5). After that, the user can click the 'save & back' button to return to conduct the following assessment in sections two and 3. Each checklist will have its own 'save & back' button to automatically save the results for each section. All buttons have been used in the VBA system accordingly, following each section to the following checklist. Every button was developed using the form control button in the developer tab. The new dialogue box will appear to write the code, and the button will automatically appear. Each section uses the same coding yet is linked with a different sheet. This button was developed for sections 2 and 3, and the end-users had to click on the right section according to their self-evaluation.

```

Sub Button2_Click()
ThisWorkbook.Sheets("Section 1").Activate
End Sub
Sub Button3_Click()
ThisWorkbook.Sheets("Section 2").Activate
End Sub
Sub Button4_Click()
ThisWorkbook.Sheets("Section 3").Activate
End Sub
Sub Button5_Click()
End Sub
Sub Button1_Click()
ThisWorkbook.Sheets("Sheet7").Activate
End Sub
Sub Sheet5_Button2_Click()
ThisWorkbook.Sheets("Main Page").Activate
End Sub
    
```

Figure 4. VBA Button coding in Macro System

Then, the user will go directly to each section one by one. It will appear and show the checklist; the button 'Section 2' will display 62 items, and the button 'Section 3' will display 15 items for evaluation. The 'Saved and back' button also uses the same coding but will only directly turn to sheet 2 to return to the 'Checklist' page Figure 5. Due to potential security risks associated with macros, Excel provides security settings to control macro execution. Users should be cautious when enabling macros from untrusted sources. After the user has settled self-evaluation for all three sections, the user will need to click on the 'Results' button to review the evaluation results. It will show the user their percentage of total 'Yes' answers using a formula of total 'Yes' scores divided into 91 items. Based on the scores, users can know and justify their score with the remarks given, just like in the complete display of Figure 6 and Table 2. It will also display the date assessment, user's name, position, employee ID, and department.

NO	PERSONNEL HYGIENE CHECKLIST	STATU
1	All employees are trained on proper handwashing. Hands are washed with proper hand-washing procedures critical points.	No
2	Facilities and supplies are adequate for proper handwashing. Easily accessible, conveniently located with soap and paper towels.	Yes
3	Uniform appropriate, clean & headwear worn e.g hair restraint, gloves and safety boots.	Yes
4	Bare hand contact with ready-to-eat and ready-to-serve food items is restricted.	Yes
5	Food workers do not handle raw foods then cooked or ready-to-eat foods without proper hand washing in between.	Yes
6	Absence of jewellery such as rings, bracelets, wristwatches, or any other items.	Yes
7	Employees handling food have no open sores, cuts, infected wounds, or bandages on hands or arms. Allowed to handle but need to use metal detectable hand/plus plaster.	Yes
8	Food workers do not handle foods if they are ill with a disease transmissible by foods or have symptoms associated with such illness.	Yes
9	Adequate supply of gloves is available to all employees.	Yes
10	Fingernails clean and trim, the hand washed before wearing gloves.	Yes
11	Employees take appropriate action washing hand and sanitize after coughing or sneezing.	Yes
12	All food employees are trained in food safety as it relates to their assigned duties. Food handlers can demonstrate food safety knowledge and competency.	Yes
13	Employees that handling food should be aware of any major allergens. Allergens: peanut, egg, milk, tree-nuts, sesame, mustard, soya, celery/celeriac and gluten.	Yes
14	Smoking not allowed in entire factory area except at smoking designated area.	Yes
Total		13

Figure 5. Example display of safety and quality self-evaluation tool section 1

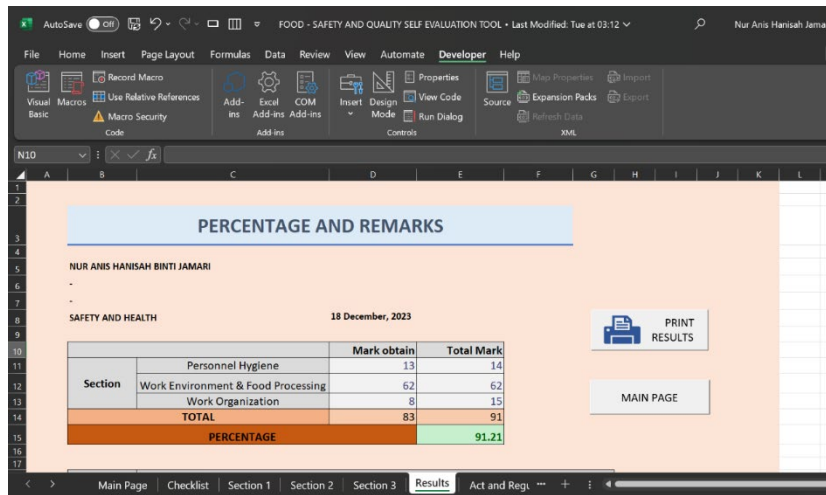


Figure 6. The completed display of self-evaluation tool results

Table 2. The percentage and remarks of the tool results [2]

Percentage	Remarks
86 – 100	Excellent job! You understand the importance of hygiene and continual improvement in food safety and quality culture, communicate well at all levels, and have management buy-in. Companies can share these excellent results with their customers and check that their suppliers are operating at the same high level.
79 – 85	You have a good understanding of the importance of food safety and quality culture within your company. Remember the importance of embedding this at every opportunity, and try to engage all staff, including senior management, shift leaders, and operatives, to strive for excellence. Good engagement and cooperation will embed best practices around food safety culture at all levels.
0 – 78	Your organization's understanding of the importance of food safety and quality culture could put your company at risk. There are clear areas for improvement of food safety and quality culture in the organization.

All the remarks used and modified from the Food Safety and Quality Culture Self-assessment questionnaire, originally from BSI Group food safety. The British Standards Institute (BSI) is a global corporate standards organization. It has a reputation for creating and disseminating industry standards and best practices that help businesses increase productivity, control risk, and achieve sustainability. BSI is a worldwide organization that collaborates with governments, corporations, and other institutions, including Malaysia. BSI provides various services, including standard development, certification, training, and evaluation. Certification services include occupational health and safety (ISO 45001), environmental management (ISO 14001), and quality management (ISO 9001). Food safety management systems, such as ISO 22000, heavily rely on a culture of food safety. A key element of maintaining the resiliency of the food sector is showcasing advancements in the culture of quality and food safety.

3.4 Case study and SUS

Table 3 tabulates the results of this safety and quality self-evaluation tool. It is helpful and runs efficiently, but due to some limitations, improvements still need to be made to ensure it is more acceptable to all users or food handlers. The finding shows that most end-users agree to the questions and give good feedback for improvements. For question 3, 'I found the food self-evaluation tool unnecessarily complex,' a 100% agreement was recorded as this tool really helps in their scope of work in the food industry. Specific end-users give feedback on the tool. For example, the tool can be used from an Excel link, not a document. The tool must also improve the contents from time to time according to the act and regulations or any amendments made. Most users are generally satisfied with the tool's development. For instance, this tool is more straightforward to use and store and immediately allows users to evaluate their hygiene. The average user also reports that it can save time and that this tool is more integrated because all the setup happens within the same system.

From the case study, the average SUS score is 68.75% and 63.75% for case 1 and case 2, respectively. However, the gap analysis of the SUS score means these two case studies were acceptable and close. Both case studies also agreed regarding the tool's improvisation for future use. The overall average SUS score was 66.25%, which can be interpreted

as "marginally acceptable" in grades between "C" and "D" [5]. Overall results show that end users find the technology effective and valuable, but several restrictions need to be addressed to guarantee wider acceptance across all food handlers.

Table 3. Percentage of SUS questionnaire results

LIKERT SCALE	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Strongly Disagree						25%		25%		
Disagree		75%				25%		75%		
Neutral		25%				50%				
Agree	25%		100%	25%	50%		75%		50%	50%
Strongly Agree	75%			75%	50%		25%		50%	50%

4.0 CONCLUSION

In conclusion, the final year project, "Safety and Quality Self-Evaluation Tool," aimed at creating a tool for assessing food safety and quality in the realm of food handling, mainly focusing on food hygiene among workers in the food and bakery industry, is achieved. This main objective has been accomplished by hook or crook with help from the food industry to ensure the usability of the tool is in a good range. The findings from the usability study, conducted through the System Usability Scale (SUS), indicated a marginal acceptability of the tool with an overall average SUS score of 66.25. This outcome may spur researchers to increase the potency of more advanced instruments. Maintaining the tool's relevance by incorporating dynamic content updates aligned with evolving regulations will also contribute to its long-term effectiveness. In short, even if the Safety and Quality Self-evaluation Tool has proven useful, the results highlight the significance of ongoing development.

5.0 ACKNOWLEDGEMENTS

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6.0 CONFLICT OF INTEREST

The authors declare no conflicts of interest.

7.0 AUTHORS CONTRIBUTION

H. A. Aziz (Conceptualization; Formal analysis; Visualisation; Supervision)

N. A. H. Jamari (Methodology; Data curation; Writing - original draft; Resources)

8.0 REFERENCES

- [1] De Boeck, E., Jaxsens, L., Bollaerts, M., & Vlerick, P. (2015). Food Safety Climate in Food Processing Organizations: Development and Validation of a Self-Assessment Tool. In *Trends in Food Science and Technology* (Vol. 46, Issue 2, Pp. 242–251). Elsevier Ltd.
- [2] Jubayer M. F, Kayshar M. S, Hossain M. S, Uddin M. N, Al-Emran M, Akter S. S. Evaluation of food safety knowledge, attitude, and self-reported practices of trained and newly recruited untrained workers of two baking industries in Dhaka, Bangladesh. *Heliyon*. 2020 Sep 1;6(9).
- [3] Ismail R. M, Abd Latiff F. A, Mustafar M. Malaysia food safety concern-bringing HACCP to the community. *The Journal of Social Sciences Research*. 2018:202-7.

- [4] Yusoff M. S. ABC of content validation and content validity index calculation. *Education in Medicine Journal*. 2019 Jun 28;11(2):49-54.
- [5] Sauro J. *A practical guide to the system usability scale: Background, benchmarks & best practices*. Measuring Usability LLC; 2011.