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AI Competency Among Students of the Bachelor of Food Technology Program at UTHM

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Abstract

The rapid development of the Fourth Industrial Revolution has introduced artificial intelligence (AI) into various sectors, including higher education and the food service industry. However, AI competency among students in the Bachelor of Food Service Technology program at UTHM remains critically low. Students show limited understanding of AI applications, ethics, and system design, compounded by digital gaps and an over-reliance on AI without ethical considerations. This study aims to determine students' level of AI competency and examine the relationships between human-centered thinking, AI ethics, AI techniques and applications, and AI system design with their AI competency. A quantitative survey method was employed, involving 80 students, and data were analyzed using descriptive and inferential statistics, including Spearman correlation. Findings show students demonstrated a high level of AI competency (mean = 3.88, SD = 0.78), with the highest mean in techniques and applications of AI (4.02) and the lowest in system design (3.71). The strongest correlation with AI competency was perceived usefulness (r = 0.742), and the weakest was AI ethics (r = 0.432). The implications of this study highlight the need for a more systematic integration of AI into the TVET curriculum, continuous professional development for educators, and stronger collaboration with smart food industries to better prepare students with industry-relevant skills. The study recommends that AI education go beyond technical proficiency to include ethical reasoning and human-centered thinking to ensure students are equipped to thrive in an increasingly digitalized food service sector. The findings serve as a basis for curriculum improvement, AI-based industrial training programs, and support national efforts to enhance graduate employability in the era of Industry 5.0.

1. Introduction

The Fourth Industrial Revolution (IR 4.0) has redefined the dynamics of global industries, particularly by embedding Artificial Intelligence (AI) as a core driver of transformation. AI technologies are now increasingly prevalent in education, manufacturing, agriculture, and especially in service-based industries like food service technology. In this era, the ability to work alongside intelligent systems and make data-driven decisions has become an essential competency for graduates (Maulana, 2024). This shift demands that higher education

institutions, particularly those within the Technical and Vocational Education and Training (TVET) stream, adapt their pedagogical approaches to nurture AI-related competencies in students.

In the food service technology, AI is no longer a futuristic tool but an operational necessity. Applications such as smart kitchens, predictive analytics for inventory management, customer behavior tracking, and food safety monitoring all rely on AI technologies (Zhang, 2024). Consequently, students pursuing degrees in food service technology must be well-versed in both the technical and ethical dimensions of AI implementation. However, research suggests that while AI tools are widely available, the competencies required to use them effectively remain underdeveloped among many graduates (Alfredo et al., 2024; Holstein & Aleven, 2022).

At Universiti Tun Hussein Onn Malaysia (UTHM), the Bachelor of Food Service Technology program is designed to prepare students with the knowledge and skills necessary to thrive in AI-integrated food industry environments. Nonetheless, concerns have been raised regarding the extent to which current curricula successfully cultivate essential AI competencies. Both academic and industry stakeholders have voiced uncertainty over whether graduates possess the critical AI literacy required to meet the demands of a digital-first, innovation-driven food sector. Despite the growing global discourse on AI in education and workforce readiness, limited empirical studies have specifically measured the AI competency levels among food service technology students in Malaysian TVET institutions. This represents a significant knowledge gap, especially when considering the need to align educational outputs with the technological demands of the local and global food industry. Therefore, this study aims to investigate the level of AI competency among students in the Bachelor of Food Service Technology program at UTHM. Guided by the AI Competency Framework, it explores the relationship between core constructs namely human-centered thinking, AI ethics, AI techniques and applications, and AI system design and students' perceived AI competency (Miao et al., 2024). The findings are expected to inform curriculum enhancement, strengthen graduate employability, and bridge the gap between higher education outcomes and industry expectations within Malaysia's evolving food service landscape.

Figure 1, AI Competency Framework for Students introduced by Miao et al. (2024) offers a comprehensive and forward-thinking structure to develop student readiness for a world increasingly shaped by artificial intelligence. It highlights the need for students to be not only technically skilled but also ethically responsible and socially aware. The framework is built upon four main interconnected dimensions which are human-centered thinking, AI ethics, AI techniques and applications, and AI system design.

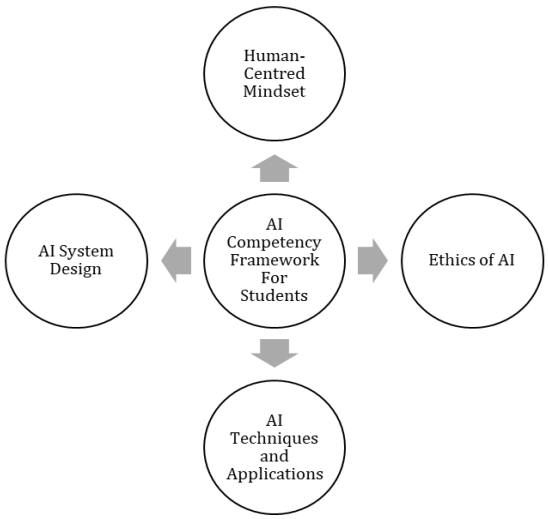

Fig. 1 *AI Competency Framework for Students (Miao et al., 2024)*

The first dimension, human-centered thinking, encourages learners to evaluate and design AI technologies based on human values, needs, and well-being (Gattupalli & Maloy, 2024). In education, this approach promotes critical reflection on how AI affects individuals, communities, and the environment. For Food Service Technology students, it fosters sensitivity towards consumer safety and public welfare. However, studies such as Alfredo et al. (2024) reveal that students are often excluded from AI system development processes, which lowers their trust and perceived control over these technologies. This highlights a gap between theoretical frameworks and real-world practice, particularly in TVET settings where user involvement is crucial.

The second dimension, AI ethics, involves the principles and values that guide the responsible development and use of AI. These include transparency, fairness, accountability, privacy, and safety. Students are expected to recognize and analyze ethical challenges related to AI implementation (Balducci, 2024). Ethical literacy in AI helps prevent data misuse and supports fair practices, especially in professions like food service (Shehab & Guo, 2021). Nonetheless, Kamali et al. (2024) found that awareness of AI ethics among educators and students remains limited, despite the increasing use of AI tools in teaching and learning. Similarly, Yang et al. (2025) noted that although students use tools like ChatGPT frequently, they often lack clear ethical guidance, suggesting a need for structured pedagogical interventions. While the AI Competency Framework promotes ethical awareness, existing studies indicate its implementation remains fragmented and under-researched in applied educational.

The third dimension focuses on AI techniques and applications. It includes knowledge of machine learning, natural language processing, expert systems, and data analytics. Students learn both theory and practice by exploring real-world uses of AI in sectors such as health, education, services, and food industries (Ngoc & Tuyen, 2022). In the food service, AI can be applied to forecast customer demands, monitor food quality, and enhance service efficiency (Amin et al., 2023). However, Sajja et al. (2023) noted that while adaptive AI assistants can reduce students' cognitive load and personalize learning, many systems are still not tailored to individual learning styles. Moreover, Hu (2024) emphasized that despite the overall improvement in student outcomes due to AI use, existing solutions lack personalization, particularly in technical education. This suggests that more contextualized applications are needed to bridge the gap between AI capabilities and learner diversity.

The final dimension is AI system design that merges technical skills with ethical considerations to produce systems that are effective, fair, and user-friendly. Students are trained to plan and evaluate AI solutions that reflect human values and social implications. For example, students in food service technology may design AI-based systems for monitoring food safety or supporting kitchen operations, which encourages creativity and problem-solving (Leong & Zhang, 2025). Nevertheless, research by Holstein & Aleven (2022) highlighted that many AI systems in education still lack participatory design approaches, reducing their adaptability to user needs. Chaudhry et al. (2022) further argued that earlier AI systems often overlooked transparency and inclusiveness, which are critical for effective learning environments. In contrast, current frameworks advocate more user-centered and socially responsive system development, indicating a shift in research priorities that requires empirical validation.

These findings underscore the limitations of previous studies that tended to focus on isolated technical competencies or failed to integrate social, ethical, and pedagogical dimensions. While the AI Competency Framework by Miao et al. (2024) presents a holistic model, its practical application across different student populations, particularly in technical and vocational fields such as food service technology, remains insufficiently explored. This study therefore seeks to fill that gap by examining the level of student AI competency through a multidimensional lens, while also evaluating the interrelationship among the framework components in a Malaysian TVET.

2. Methodology

This study employed a quantitative research design to examine the level of AI competency among students enrolled in the Bachelor of Food Service Technology program at Universiti Tun Hussein Onn Malaysia (UTHM). The study population consisted of 102 students from Years 1 to 4, and a sample of 80 students was selected using simple random sampling. This method ensured equal selection probability and a balanced representation of academic levels, consistent with recommendations by Cash et al. (2022). The quantitative approach enabled systematic measurement of students' perceptions and competencies through numerical data.

A structured questionnaire served as the main research instrument and was developed based on the AI Competency Framework for Students by Miao et al. (2024), which includes five domains: human-centred mindset, ethics of AI, AI techniques and applications, AI system design and AI competency. All items were adapted from validated studies to ensure accuracy and consistency. A pilot study involving 30 students was carried out to refine item clarity and language suitability, leading to improvements in wording and construct alignment, as supported by Bujang et al. (2024). Reliability results showed strong internal consistency across all constructs, with Cronbach's alpha values ranging from 0.736 to 0.932, indicating acceptable to excellent reliability in line with Ramly et al. (2024). Content validity was also confirmed through expert review by two lecturers and a language specialist.

The questionnaire consisted of six sections with a total of 27 items measuring the study constructs. Section A gathered demographic information such as gender, age, year of study, and prior exposure to AI. Sections B to F assessed the five AI competency dimensions, including five items for human-centered thinking, four for AI ethics, six for AI techniques and applications, seven for AI system design, and five for overall AI competency. All items used a five-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree," which is widely

recognized for effectively capturing attitudes and perceptions in social science research (Zawacki-Richter et al., 2019).

Data collection was conducted over three weeks using Google Forms, distributed through official WhatsApp groups and direct messages to ensure wide accessibility among students. Participants were informed about the study purpose, confidentiality, and voluntary nature of participation before completing the questionnaire. Normality of the data was assessed using Z-tests for skewness and kurtosis, appropriate for medium-sized samples as recommended by Kim (2013). Since several constructs did not meet normality assumptions, both Pearson and Spearman correlation analyses were applied depending on the distribution of each variable. This dual analytical approach strengthened the accuracy and validity of the findings, consistent with recommendations by Habibzadeh (2024) and Hatem et al. (2022).

3. Results and Discussion

This study involved 80 undergraduate students from the Bachelor of Food Service Technology program at UTHM. The demographic analysis included gender, age, year of study, AI exposure, participation in external AI courses, and experience with AI in the food industry. The majority of respondents were female 70%, while 30% were male, which indicates a female-dominated enrolment in the program. Most participants were aged between 23–25 years (66.2%), followed by 20–22 years (33.8%), reflecting the typical age range of undergraduate students. In terms of academic level, Year 2 students accounted for the highest proportion (35%), followed by Year 1 (32.5%), Year 3 (31.2%), and Year 4 (1.3%). Regarding AI exposure, 73.8% of students had heard about AI, 40% had learned AI in academic courses, and 66.2% had used AI-based applications such as Gemini or DeepSeek. However, none reported any other form of AI exposure. Furthermore, 33.8% of students had attended AI-related courses outside the university, while the remaining 66.2% had not. Notably, 59 students (73.8%) had experience using AI in the food industry, while 21 students (26.2%) reported no such experience. This indicates that although a majority of students had practical engagement with AI, over a quarter lacked direct industry-related AI experience.

3.1 Human-Centred Mindset Level

Table 4.1 presents the findings on the level of human-centred mindset among students in the Bachelor of Food Service Technology program at UTHM is high, with a mean score of 4.04 and a standard deviation of 0.81. This suggests that students have a strong awareness of the importance of embedding human values in the development and application of artificial intelligence (AI), particularly within the food service technology industry. Students tend to perceive AI as a tool designed to assist humans rather than replace them, placing emphasis on user safety, workload reduction, and stakeholder comfort. These findings reflect the students' understanding of AI as a supportive technology that promotes human well-being, aligning with the principles of responsible and ethical technology design.

Table 1 *Level of Human-Centred Mindset Among Students*

Item	Statement	Mean	SD	Interpretation
B1	AI should be designed to assist humans in the food service industry.	4.06	1.04	High
B2	AI should be developed based on human values.	3.96	0.95	High
B3	AI should ensure user safety in food service operations.	4.13	1.00	High
B4	AI can help reduce human workload.	4.03	1.02	High
B5	AI should prioritise the comfort of workers and customers.	4.00	0.97	High
	Total	4.04	0.81	High

3.2 Ethics of AI Level

Table 2 presents the findings indicate that students' awareness of ethics in the use of artificial intelligence (AI) is high, with a mean score of 4.12 and a standard deviation of 0.68. Students demonstrated a strong understanding that ethical considerations must be prioritized in AI implementation, particularly within the food service technology industry, which involves consumer safety and data privacy. The highest score was recorded for items related to the need for monitoring AI systems, reflecting students' heightened awareness of the risks of technological misuse. Although the item concerning the necessity of human oversight in critical decision-making received the lowest score among the items, it was still acknowledged as important. These findings suggest that students not only understand the potential of AI but also recognize the ethical responsibilities associated with its use, in line with the goals of sustainable and integrity-driven technological development.

Table 2 *Level of AI Ethics Among Students*

Item	Statement	Mean	SD	Interpretation
C1	AI must comply with ethics and safety regulations in the food service industry	4.14	0.98	High
C2	AI needs to be monitored to prevent any form of misuse	4.24	0.78	Very High
C3	AI should require human review when making critical decisions	4.04	1.01	High
C4	AI must ensure that customer data privacy is always protected	4.08	0.95	High
	Total	4.12	0.68	High

3.3 AI techniques and applications Level

The results from Table 3 shows that students' competency in AI techniques and applications is at a high level, with a mean score of 3.72 and a standard deviation of 0.81. This indicates that students possess solid knowledge and awareness of how AI can be applied across various operational aspects of the food service industry. Although item scores varied, all remained within the high category, reflecting students' understanding of AI applications in areas such as restaurant automation, food delivery systems, raw material monitoring, and customer needs analysis. The highest score was recorded for the application of AI in customer data analysis, highlighting students' ability to appreciate AI's role in improving information management efficiency. The lowest score, which related to AI in food demand forecasting, suggests room for improvement in students' mastery of predictive analytics. In conclusion, students appear well-prepared to leverage AI effectively in creating smarter and more efficient food service operations.

Table 3 *Level of AI Techniques and Applications Among Students*

Item	Statement	Mean	SD	Interpretation
D1	AI can be used to predict food demand	3.36	1.00	High
D2	AI is used for automation in restaurants	3.75	0.96	High
D3	AI can monitor the quality of raw ingredients	3.79	1.27	High
D4	AI can analyse customer taste preferences	3.44	1.07	High
D5	AI is applied in food delivery systems	3.89	1.09	High
D6	AI helps analyse customer data more efficiently	4.11	1.02	High
	Total	3.72	0.81	High

3.4 AI system design Level

The findings in Table 4 indicate that students' understanding of artificial intelligence (AI) system design is at a high level, with a mean score of 4.05 and a standard deviation of 0.87. This reflects the students' strong ability to grasp fundamental concepts of AI system design and its applications in the management and operation of food service environments. Students demonstrated awareness of the importance of AI in data processing, simple system planning, and proposing improvements to existing systems, as evidenced by the highest score in items related to system innovation. Although the item on inventory monitoring recorded the lowest mean score, it still fell within the high category, indicating a comprehensive understanding across all aspects of AI system design. These findings underscore that students are not merely users of technology but also have the potential to become creators and contributors to the development of systematic, efficient, and competitive AI systems in the food service industry.

Table 4 *Level of AI System Design Among Students*

Item	Statement	Mean	SD	Interpretation
E1	AI is designed based on the basic concepts of systems	4.09	1.07	High
E2	AI can be used to monitor raw material inventory	3.84	0.89	High
E3	AI processes customer data efficiently	4.11	0.94	High
E4	AI needs to be trained using food-related data	4.09	1.05	High
E5	AI is used to design basic ideas for AI systems in restaurants	3.96	1.14	High
E6	AI is used to suggest improvements to existing AI systems	4.15	1.04	High
E7	AI can plan simple systems for restaurant use	4.13	1.01	High
	Total	4.05	0.87	High

3.5 Relationship between Human-Centred Mindset, AI Ethics, AI Techniques and Applications, AI System Design and Student AI Competence

Based on the normality test results in Table 5, only the constructs of AI techniques and applications as well as students' AI competency exhibited a normal distribution, whereas human-centered thinking, AI ethics, and AI system design did not meet normality assumptions. Therefore, Spearman's correlation analysis was used for these constructs. The analysis revealed that all variables had significant relationships with students' AI competency, albeit with varying strengths. AI system design demonstrated the strongest relationship ($\rho = 0.795$, $p = 0.000$), indicating that understanding the structure, functions, and safety features of AI systems has a substantial impact on students' competency. Human-centered thinking showed a strong moderate relationship ($\rho = 0.663$, $p = 0.000$), reflecting the importance of human values such as empathy and social responsibility in AI mastery. Meanwhile, AI ethics recorded a moderate but significant relationship ($\rho = 0.389$, $p = 0.000$), underscoring the relevance of understanding issues related to privacy, data security, and moral responsibility. Overall, these findings indicate that students' AI competency is influenced not only by technical aspects but is also strengthened by values, ethics, and human-centered perspectives, aligning with the holistic aspirations of TVET education.

Table 5 *Spearman Correlation Analysis for Study Variables and Students' AI Competency*

Variable	Spearman Correlation (ρ)	p-value (Sig.)	Interpretation
Human-centered thinking	0.663	0.000	Moderate
AI ethics	0.389	0.000	Moderate
AI system design	0.795	0.000	Strong

Overall, the findings indicate that students demonstrate a high level of AI competency, with positive perceptions towards the use and application of AI in the food service. They exhibit strong understanding in areas such as human-centered thinking, AI ethics, techniques and applications, as well as AI system design. Notably, students are not only prepared to use AI technologies but also show potential to contribute as creators of sustainable AI systems relevant to their field. Significant correlations were found between all constructs and AI competency, with the strongest relationship observed in AI system design, highlighting the importance of technical skills. However, human-centered thinking and ethics also played a crucial role, suggesting that balanced AI competency requires both technical proficiency and social responsibility. The study also found that students' formal exposure to AI can be further enhanced through practical learning and curriculum integration. Strengthening hands-on experience is vital to develop TVET graduates who are not only technologically literate but also ethically and innovatively prepared for real-world applications.

3.6 Level of Human-Centred Mindset Among Students

The findings reveal that students exhibit moderate levels of human-centered thinking in applying AI, suggesting a gap between theoretical awareness and practical integration of ethical and social dimensions. This may be attributed to a curriculum that prioritizes technical proficiency over ethical reasoning, or to a lack of experiential learning opportunities that reinforce human values in real-world AI applications. Although students recognize the relevance of ethics (Ritschard & Schuppler, 2024), their limited implementation in practice indicates that awareness alone does not translate into behavior without structured support and contextual application.

This observation aligns with Castillo-Martínez et al. (2024) and Ystgaard & De Moor (2023), who emphasize that embedding human-centered design and ethical reflection within instructional modules significantly improves students' empathy and critical thinking. However, compared to these studies, the present findings show a weaker practical uptake, possibly due to differences in institutional emphasis or teaching methodologies. For example, institutions in the cited studies may have had more established ethical AI curricula or interdisciplinary teaching approaches. Moreover, the data suggest that overreliance on AI tools among students may impair their critical thinking and social interaction skills (Ramos et al., 2024; Garcia-Lopez et al., 2020). This effect could stem from the convenience and automation that AI provides, which, while increasing efficiency, may reduce opportunities for independent decision-making and human collaboration. These consequences appear more pronounced in disciplines like food service technology, where interpersonal interaction and situational judgment are essential.

In addition, digital inequalities, especially among rural students, continue to exacerbate disparities in AI competency development (Balducci, 2024; Shoeibi et al., 2023). Students with limited access to high-speed internet or up-to-date digital tools may struggle to engage in advanced AI learning activities that include ethical simulations or human-centered case studies. Dastyari & Jose (2024) argue that such gaps can only be addressed

through systemic infrastructural reforms, such as inclusive broadband policies and equitable digital resource allocation. In conclusion, while students in this study demonstrate some understanding of the human-centered aspects of AI, their ability to translate this into applied competencies remains insufficient. The results support the hypothesis that human-centered thinking significantly influences AI competency, but also point to structural, pedagogical, and access-related factors that constrain its development. To address this, institutions must foster value-driven AI education that balances technical instruction with ethics, inclusivity, and social responsibility.

3.7 Level of AI Ethics Among Students

The findings indicate that students demonstrate a high level of awareness regarding AI ethics, especially in the context of responsible and safe technology use in the food service industry. This strong ethical awareness may be shaped by increased media exposure to data misuse and algorithmic bias, as well as formal education on the social impact of technology. Students' strong agreement on the importance of monitoring AI systems to prevent misuse reflects a growing concern about accountability mechanisms. This interpretation aligns with Ravi et al. (2023), who stress the role of transparency and oversight in building ethical AI systems. Furthermore, Z. Wang et al. (2025b) found similar results in which ethical instruction led to heightened vigilance towards AI misuse, suggesting that targeted ethics education positively influences students' risk perception. However, a more nuanced interpretation reveals that students show lower levels of agreement when it comes to the necessity of human oversight in critical AI-driven decision-making. While still within a "high" range, this relative drop suggests a potential overreliance on AI systems, possibly driven by misconceptions that AI is more accurate, neutral, or objective than human judgment. This tendency is consistent with findings by Zhou et al. (2022), who observed that students in technical disciplines tend to regard AI systems as infallible, often neglecting the risks of algorithmic bias or malfunction. Such uncritical trust may hinder the development of independent judgment and critical thinking, which are essential in food service scenarios where human oversight remains irreplaceable. Winingsih et al. (2022) also warned that blind reliance on AI can result in ethical disengagement and poor decision-making, highlighting the need for curricula that reinforce human responsibility, particularly in high-stakes environments.

Moreover, the findings confirm that privacy and data protection are major ethical concerns among students. This is significant, as it suggests that students are not only aware of visible, operational risks but also of the less tangible risks such as surveillance, data leaks, and breaches of autonomy. This observation aligns with the work of Jobin, Ienca & Vayena (2019) and Morley et al. (2020), who identified data privacy as one of the most pressing ethical concerns in AI adoption. Notably, unlike some earlier studies where privacy awareness was lower among non-technical users, the students in this study—although not AI specialists—still demonstrate strong ethical engagement, indicating the positive impact of contextual ethics education even in applied fields like food service technology. In summary, while students show promising levels of AI ethical awareness, the relative undervaluation of human oversight reveals a gap that must be addressed to prevent ethical complacency. The findings confirm a significant positive relationship between AI ethics and students' AI competency, echoing the position of Ystgaard & De Moor (2023) that ethics-integrated education nurtures both moral responsibility and practical skill. Therefore, ethics instruction should go beyond theoretical discussion and incorporate real-world case studies, critical incident analysis, and simulation-based learning to train students not only to understand ethical principles but to apply them consistently. In doing so, institutions can ensure that graduates of food service technology programs emerge as not just technologically capable, but also ethically grounded AI users.

3.8 Level of AI Techniques and Applications Among Students

The study reveals that students demonstrate a high level of understanding regarding AI techniques and applications, particularly in areas closely aligned with the customer-facing functions of the food service industry. Their awareness of AI's role in customer data analysis indicates that students are well attuned to how AI supports decision-making through behavior analytics, menu customization, and personalized marketing. This aligns with Chookaew et al. (2024) and Kumar et al. (2021), who emphasize that AI's ability to synthesize customer data can significantly improve service quality and operational efficiency. This strong awareness could stem from exposure to real-life digital platforms used in food service (e.g., food delivery apps, CRM systems), which often provide visible and relatable examples of AI implementation. However, the study also identifies comparatively lower understanding of AI's predictive capabilities, such as demand forecasting and algorithm-based inventory control. While still categorized as "high," the relative gap suggests that students may not be equally exposed to machine learning concepts, particularly those that operate behind the scenes. Unlike data visualization or user feedback tools, predictive modeling requires deeper technical knowledge and experience with large datasets skills that are typically underrepresented in vocational or application-focused curricula. This interpretation is consistent with Addanki et al. (2022) and Naseem & Rizwan (2025), who highlight that prediction tasks in AI depend on familiarity with time-series data, environmental patterns, and statistical reasoning, which are not commonly emphasized outside of technical computer science or engineering programs. Another contributing factor to this gap may be

the lack of hands-on experience with AI tools in real-world settings. Students often study AI in a conceptual or theoretical context, without the opportunity to engage directly with software or platforms that utilize predictive analytics. Sajja et al. (2023) argue that this disconnect between classroom content and industry tools leads to surface-level understanding of AI functions. Similarly, Garcia-Lopez et al. (2020) note that technical literacy can only be meaningfully developed through industry-aligned AI modules, where students are challenged to apply AI in solving practical business problems. These findings indicate that while students grasp general applications of AI, their capacity to engage with more advanced and abstract AI techniques is still evolving.

Despite this limitation, the study confirms that students are highly familiar with AI's role in automation, food delivery logistics, and raw material management areas that are increasingly digitized across the food service sector. This reflects their practical orientation and awareness of industry trends, supporting the claim by Qawqzeh (2024) that AI serves as a core driver of operational transformation in food services. However, to fully capitalize on AI's potential, it is essential that students are not only exposed to visible applications but are also trained to understand the underlying mechanisms and algorithms that power those systems. In conclusion, the findings support a significant relationship between students' mastery of AI techniques and their overall AI competency, underscoring the need for more technical depth in areas such as machine learning, data modeling, and predictive analysis. As recommended by Zawacki-Richter et al. (2019), integrating project-based learning and industry partnerships can provide students with experiential learning opportunities that reinforce theoretical knowledge through practical application. By strengthening the technical dimension of the curriculum, institutions can ensure that students are not only capable of using AI tools but also of understanding, adapting, and innovating with them preparing them to thrive in an industry undergoing rapid digital transformation.

3.9 Level of AI System Design Among Students

The study found that students demonstrate a high level of understanding in AI system design, reflecting not only their theoretical knowledge but also a growing awareness of how AI systems are developed, trained, and optimized for specific applications in the food service industry. This suggests that students are increasingly attuned to the practical dimensions of AI integration, particularly in enhancing customer experience and operational efficiency. One possible explanation for this high competency may be the inclusion of course elements that promote system thinking and exposure to digital tools, even if indirectly. The ability of students to recognize AI's role in suggesting improvements to existing systems indicates a shift from passive adoption to proactive innovation. This supports the findings of Wu et al. (2024), who emphasized that students exposed to problem-based learning are more likely to conceptualize AI as a tool for continuous improvement rather than mere automation. Critically comparing these findings to earlier work, the current results align with X. Zhai et al. (2021) and Leong & Zhang (2025), who found that AI applications in real-time customer data processing and predictive menu planning are becoming increasingly understood by students. However, the relatively lower familiarity with AI-based inventory monitoring systems reveals a potential weakness in students' understanding of back-end operational design. This could be due to the limited coverage of supply chain and logistics modules within the curriculum, or a lack of practical exposure to technologies such as IoT that underpin inventory tracking. This gap reflects a broader issue noted by Harry (2023) and Lee et al. (2023), who argue that while students may grasp front-end AI functions well, back-end systems require more technical and contextual learning, which is often underrepresented in vocational and technical training programs.

Syahputra et al. (2024) reinforce this interpretation by highlighting that the lack of real-world application during training contributes to poor understanding of AI in inventory systems. Similarly, Baldevbhai et al. (2025) stress the importance of integrating hands-on experiences and industry engagement to bridge this knowledge gap. The discrepancy in understanding between front-end and back-end system design reveals a curriculum imbalance that needs addressing to ensure students acquire holistic AI competencies. As S. Wang et al. (2024) argue, curriculum redesign that encompasses both technical and operational AI design elements is crucial to preparing students for the complexities of digital transformation in the food service sector. Overall, the findings support the hypothesis that AI system design competency is significantly related to overall AI competency. However, the nature of this relationship is nuanced strong in areas related to customer interaction and system improvement, but weaker in foundational technical infrastructure like inventory management. This suggests that while students are well-positioned to contribute to innovation in visible service aspects, their ability to manage behind-the-scenes systems may remain underdeveloped without targeted intervention in educational strategies.

3.10 Relationship between Human-Centred Mindset, AI Ethics, AI Techniques and Applications, AI System Design and Student AI Competence

The findings demonstrate significant correlations between all constructs human-centered thinking, AI ethics, AI techniques and applications, and system design and students' AI competency. This supports the hypothesis that AI competency is multifaceted, shaped by both technical proficiency and value-oriented awareness (Miao et al., 2024). Among the constructs, AI system design exhibited the strongest correlation, implying that students who

understand how AI systems function, their usability, and practical benefits tend to perform better in AI-related tasks (Zhang, 2025; Nguyen et al., 2023). This aligns with the work of Wang and colleagues (2022), who found that usability and system familiarity significantly predict AI adoption in vocational education. The relatively weaker but still significant correlations for human-centered thinking and AI ethics suggest that these dimensions play a supportive but not primary role in building AI competency. One possible explanation is the structure of the curriculum itself, which tends to emphasize technical execution over ethical reasoning. This mirrors the findings of Kamali et al. (2024), who noted that students in technical programs often lack contextual opportunities to apply ethical principles, resulting in a disconnect between awareness and practice.

AI ethics, in particular, had the lowest correlation with competency. This could reflect the theoretical and abstract nature of ethics instruction in many technology programs, where students are seldom exposed to real-life dilemmas involving data privacy, algorithmic bias, or accountability (Selvaratnam & Venaruzzo, 2024; Zhou et al., 2025). In contrast, practical exposure to AI tools in food service operations such as automation, inventory control, and personalized menus likely contributes more directly to competency. In sum, while technical mastery is a clear driver of AI competency, the findings reinforce the need for more integrative approaches that embed human values and ethics into real-world learning scenarios. This supports Falebita and Kok's (2024) argument that responsible AI education should balance hands-on skills with critical reflection to develop competent and ethical practitioners.

4. Conclusions

This study provides a comprehensive overview of AI competency among students in the Bachelor of Food Service Technology program at UTHM. By assessing four key dimensions, such as human-centered thinking, AI ethics, techniques and applications, and system design. The findings reveal not only students' competency levels but also the interrelations among these elements in shaping holistic AI readiness. Despite its contributions, the study has limitations. It is confined to a single institution, focuses solely on student perspectives, and uses only questionnaire-based data. These factors may restrict the generalizability and depth of insights. Future research should involve multiple institutions and stakeholders, including educators and industry professionals, to enhance contextual understanding. Nevertheless, the findings offer valuable implications. For students, it highlights the need to master both technical and ethical aspects of AI. Educational institutions may use the insights to improve curricula and training. The food service industry may benefit from aligning workforce development with current AI demands. Policymakers can also refer to the results in formulating more inclusive education and digital competency strategies. Ultimately, this study serves as a foundation to strengthen student preparedness in facing the demands of the AI-driven food service industry in the era of the Fourth Industrial Revolution. Based on the findings, several directions for future research are proposed to further enhance understanding and development of AI competencies among food service technology students. Future studies could compare AI competency levels among students from various public and private higher education institutions in Malaysia. Such comparisons would provide a broader overview of students' achievements in mastering AI within the national higher education context. A longitudinal approach is recommended to track the progression of students' AI competencies from their first year to final year. This would allow researchers to assess the influence of curriculum content and AI exposure over time. Future research could also implement AI-based training modules or workshops and evaluate their effectiveness in enhancing both technical and ethical AI competencies. This would offer insights into the practical impact of structured interventions on student outcomes.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Farah 'Adilah Nordin, Norhasyimah Hamzah;* ***data collection:*** *Nur Farah 'Adilah Nordin;* ***analysis and interpretation of results:*** *Nur Farah 'Adilah Nordin, Norhasyimah Hamzah;* ***draft manuscript preparation:*** *Nur Farah 'Adilah Nordin, Norhasyimah Hamzah. All authors reviewed the results and approved the final version of the manuscript.*

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