

The Role of Bakery and Pastry Programmes in Developing Future Competencies among Vocational College Students in Malaysia: Issues and the Need for Transformation

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DOI Link: <http://dx.doi.org/10.6007/IJARPED/v15-i3/29047>

Published Online: 30 September 2026

Abstract

This review examines how Malaysian vocational college bakery and pastry education can develop the competencies required for contemporary employment, entrepreneurship, and continued occupational learning. The evidence indicates a dual condition. Students are generally motivated and report strong employability, yet more specific studies identify moderate workplace skills, incomplete exposure to teamwork, leadership, technical, ethical, analytical, and problem-solving capabilities, and uneven readiness for digital transformation. The program's strongest educational assets are hands-on practice, teacher demonstration, practical feedback, modular learning, and contact with industry. Its recurring weaknesses are a weak or episodic connection between curriculum and employers, insufficient laboratory resources and protected practice time, inconsistent assessment of authentic performance, and limited evidence about graduates' actual employment and business outcomes. Transformation therefore should not mean simply adding digital tools to a recipe-based curriculum. It should connect occupational standards, bakery production, food safety, product development, costing, digital commerce, sustainability, halal assurance, and employability skills through authentic production and work-based learning. The most defensible reform model is cyclical: employers and educators jointly specify competencies, colleges provide repeated and well-resourced practice, assessment captures observable performance, and graduate and employer outcomes feed the next curriculum revision.

Keywords: Bakery and Pastry Education, Vocational Education, Future Competencies, Employability Skills, Curriculum Transformation

Introduction

Malaysia's hospitality and foodservice education have expanded alongside an industry that requires a more capable workforce, making curriculum relevance and stakeholder alignment central concerns rather than peripheral issues. A Malaysian review of hospitality and tourism education identified the need to examine whether curriculum content reflects expectations from educators and industry practitioners and argued for programmes that can adapt to a changing employment environment (Yusof, 2010). This concern is especially pertinent to

bakery and pastry because occupational competence combines precise manual production with food safety, quality control, presentation, communication, teamwork, speed, costing, and the capacity to adapt products to consumer and market changes.

The Malaysian evidence is mixed in a revealing way. A large survey of 841 final-year students in bakery and culinary programmes across 22 vocational colleges found that 93.2% reported a high level of hospitality employability competence (Ahmad et al., 2017). Yet a related analysis of the same broad student population found significant gaps between the importance students assigned to teamwork, leadership, basic, technical, and ethical skills and the competence they believed they had attained; culinary and bakery students also reported inadequate exposure to several competencies (Kenayathulla et al., 2019). These findings are not necessarily contradictory. A high aggregate self-rating can coexist with deficits, less frequently practiced capabilities, especially when competence is measured by self-report rather than observed performance or employer assessment.

This review asks what the Malaysian bakery and pastry programme must transform to develop future competencies. It treats bakery and pastry as a specialist case within hospitality TVET while using adjacent culinary, food-processing, and hospitality studies where they illuminate curriculum, pedagogy, industry linkage, or future skills. Primary empirical studies are prioritized for samples, measured outcomes, and study methods; reviews and conceptual work are used for field-level interpretation. The analysis focuses on programme relevance, occupational and transversal competencies, pedagogy and industry partnerships, implementation constraints, and a transformation agenda that remains feasible for vocational colleges.

Programme Context and the Malaysian Competency Problem

Bakery and Pastry as a Strategic TVET Pathway

Bakery and pastry education represents a strategic TVET pathway because it integrates craft skills, food production, hospitality services, and entrepreneurship. In Malaysian vocational education, food-related programmes, including culinary and bakery-pastry fields, continue to attract students and require institutions to strengthen programme quality and relevance to industry needs (Tukiran et al., 2021). The occupational scope of bakery and pastry extends beyond employment in hotels and restaurants to cafés, retail outlets, event catering, food manufacturing, and home-based enterprises. Consequently, competence should not be defined solely by the ability to reproduce standard recipes but should encompass technical production, quality assurance, problem solving, teamwork, resource management, entrepreneurship, and adaptability.

The importance of practical foundations is also evident in Malaysian culinary education. Zahari and Awang (2014) found that students entering culinary programmes from vocational schools demonstrated stronger basic cooking knowledge than students from other educational backgrounds, while students with limited prior knowledge required more time to acquire culinary knowledge and skills. Although the study was conducted within culinary arts rather than bakery and pastry specifically, the findings suggest that prior practical exposure can provide an important foundation for more advanced occupational learning. This highlights the importance of identifying students' entry-level competencies and providing

differentiated learning opportunities rather than if all learners begin with similar knowledge and practical experience.

From Qualification to Occupational Capability

The development of bakery and pastry education should therefore move beyond qualification attainment towards demonstrated occupational capability. Malaysian hospitality employers have identified a broad range of competencies extending beyond technical knowledge. A Delphi study involving industry experts identified 69 competencies grouped into workplace, personal-effectiveness, management, and academic domains (Shariff & Razak, 2021). Similarly, culinary competency research involving Malaysian educators and industry practitioners has identified competency frameworks encompassing technical and professional capabilities required for sustainable careers (Suhairom et al., 2016, 2019). Although these studies do not provide direct evidence of competency levels among Malaysian vocational-college bakery and pastry students, they demonstrate that occupational readiness requires the integration of technical performance with interpersonal, managerial, cognitive, and professional capabilities.

This broader competency perspective is particularly important as bakery and pastry occupations increasingly require workers to operate within complex production and business environments. Graduates are expected not only to produce consistent products but also to maintain food safety and quality, manage time and resources, communicate effectively, respond to production problems, work collaboratively, and adapt to changing consumer and industry requirements. The programme content should therefore provide repeated opportunities for students to integrate technical skills with higher-order and workplace competencies through authentic production activities.

From Perceived Employability to Demonstrated Competence

Evidence of students' perceived employability provides an encouraging foundation but should be distinguished from demonstrated occupational competence. Ahmad et al. (2017) reported a high level of perceived competence among Malaysian hospitality students, indicating that students generally viewed themselves as possessing employability capabilities. However, questionnaire-based self-perceptions cannot establish whether students can consistently perform to industry standards under authentic workplace conditions. Similarly, Kenayathulla et al. (2019) identified gaps between the perceived importance and competence of employability skills, including teamwork, leadership, technical skills, and ethical competencies, with concerns regarding exposure within culinary and bakery-related programmes. These findings suggest that confidence may coexist with weaknesses in specific competency domains.

Accordingly, programme development should distinguish between perceived readiness and demonstrated capability. Student self-assessment remains valuable for identifying learning needs and perceptions, but it should be complemented by practical performance assessment, product-based evidence, instructor observation, workplace-supervisor feedback, and graduate outcomes. Such triangulation would provide a more comprehensive understanding of whether programme content is producing competencies that can be transferred effectively into employment and entrepreneurial contexts.

Programme Transformation Through Alignment

The transformation of bakery and pastry education should ultimately be understood as a process of alignment among occupational requirements, programme content, authentic learning experiences, assessment practices, and post-graduation outcomes. Malaysian vocational colleges already have an institutional foundation for such alignment through collaborative industry practices, including student on-the-job training, programme quality assurance, human-capital development, and professional knowledge sharing (Sappar et al., 2024). However, industry collaboration becomes meaningful for curriculum transformation only when employer input directly influences the competencies taught, learning activities provided, opportunities for repeated practice, assessment of performance, and subsequent curriculum revision.

Therefore, the development of future-ready bakery and pastry education requires a shift from a predominantly task- and recipe-oriented approach towards an integrated competency-based model. Technical mastery should remain central, but it should relate to problem solving, creativity, communication, teamwork, digital capability, entrepreneurship, food safety, sustainability, and adaptability. Through stronger alignment between industry expectations and what students learn, practice, demonstrate, and ultimately apply in the workplace, bakery and pastry education can function as a broader pathway for skilled employment, career development, and enterprise creation rather than merely as preparation for routine production tasks.

Technical and Occupational Competencies

Technical Production Competencies in Bakery and Pastry Education

Bakery and pastry education requires strong psychomotor precision, practical mastery, food safety, and quality control. Unlike knowledge-based learning that can be demonstrated primarily through written assessment, bakery and pastry competence depends substantially on repeated and observable production performance. Evidence from 90 students undertaking industrial training in four bakeries in Yogyakarta found psychomotor ability to be the most highly needed competency domain, followed by affective and cognitive abilities (Rachmawati et al., 2019). Although these findings originate from Indonesia and should not be interpreted as Malaysian estimates, they illustrate the occupational importance of practical mastery in activities such as weighing, scaling, mixing, fermentation control, shaping, baking, finishing, storage, and defect correction. Malaysian culinary research similarly indicates that practical modular learning can contribute to improvements in students' knowledge, skills, confidence, and psychomotor performance (Rahman et al., 2016). However, completion of a practical module should not automatically be equated with commercial competence. Programme content should instead be structured around progressive mastery, repeated practice, guided feedback, and observable product and process outcomes.

Food safety and quality control should form an integral component of this technical foundation. Evidence from vocational production-unit learning indicates that participation in authentic food production can develop sanitation and hygiene practices alongside discipline, independence, creativity, communication, decision making, time management, and leadership (Evawati, 2020). In bakery and pastry education, hygiene and quality should therefore be embedded throughout production activities, including personal hygiene, equipment sanitation, ingredient handling, storage, traceability, allergen awareness,

packaging, labelling, and corrective action. Assessment should capture these practices during authentic production rather than relying primarily on written examinations. Observable criteria for hygiene, process control, product consistency, waste management, and quality assurance would provide a more meaningful basis for determining students' technical readiness.

Technical competency should also include the ability to develop and improve bakery products. Culinary competency frameworks have highlighted the importance of technical capabilities for sustainable professional development (Suhairom et al., 2016), while bakery-related research has proposed combining technical skills, soft skills, and entrepreneurship through a Bakepreneurship learning model (Syarbini et al., 2020). Although the latter provides a useful design reference rather than direct evidence of Malaysian vocational-college outcomes, it reinforces the need to move beyond recipe reproduction. Within the Malaysian context, product development can be developed through activities requiring students to modify formulations, test texture and shelf life, calculate yield and production costs, evaluate sensory quality, develop packaging, and justify product decisions according to consumer, cultural, nutritional, or sustainability considerations. Such activities would strengthen creativity, experimentation, analytical thinking, and product-development capability alongside technical production skills.

Occupational and Industry-Related Competencies in Bakery and Pastry Education

Technical production skills alone are insufficient for effective occupational performance. Bakery and pastry professionals operate within production systems that require the coordination of people, ingredients, equipment, schedules, orders, costs, quality standards, and customer requirements. Malaysian hospitality employers have identified competencies across workplace, personal-effectiveness, management, and academic domains, demonstrating that occupational readiness extends beyond technical task performance (Shariff & Razak, 2021). Similarly, Mansor and Rus (2020) demonstrated the feasibility of developing a generic-skills curriculum model within Malaysian vocational colleges through systematic needs analysis and expert validation, although the study focused on food processing rather than bakery and pastry specifically. These findings suggest that communication, teamwork, time management, problem solving, decision making, and resource management should be deliberately incorporated into bakery and pastry education rather than being left to incidental classroom experiences.

Occupational competence should also include the ability to identify and respond to production problems. Students should be exposed to authentic situations involving product defects, equipment limitations, ingredient variation, production delays, quality deviations, and changing customer requirements. Rather than being assessed solely on whether a final product meets a prescribed standard, students should be required to diagnose problems, identify possible causes, select corrective actions, and explain their decisions. This approach would connect technical knowledge with higher-order thinking and workplace problem solving.

The development of occupational versatility is particularly important because bakery and pastry graduates may enter diverse employment and enterprise contexts, including hotels, restaurants, cafés, bakeries, food manufacturing, catering, retail, and small businesses.

Programme content should therefore enable students to apply technical competencies across different production conditions while maintaining consistent standards of safety and quality. Enterprise-related competencies such as costing, purchasing, production planning, customer communication, product presentation, and basic marketing can further strengthen students' capacity to transfer technical skills into employment or self-employment.

Taken together, the evidence indicates that bakery and pastry education should progress from technical production mastery towards integrated occupational capability. Technical competencies should establish the foundation for accurate, safe, and consistent production, while occupational competencies should enable students to apply these skills within complex workplace and enterprise environments. The integration of both domains would provide a stronger foundation for future-ready graduates who can not only produce bakery and pastry products but also solve production problems, manage resources, work collaboratively, develop products, respond to customer and industry needs, and adapt their skills to changing occupational contexts.

Transversal and Future Competencies

Transversal Workplace Competencies in Bakery and Pastry Education

Future-ready bakery and pastry education requires the integration of technical competence with communication, teamwork, leadership, problem solving, and analytical thinking. Malaysian evidence indicates that employability extends beyond technical execution. Kenayathulla et al. (2019) identified gaps between the perceived importance and attained competence of teamwork, leadership, technical, and ethical skills among Malaysian students. Similarly, Mohamed et al. (2021) found that workplace skills and perceived teacher competency among final-year Culinary Arts students in Malaysian vocational colleges were moderate and positively correlated. Although the correlational design does not establish causality, the findings highlight the potential importance of teacher practice in connecting technical learning with workplace competencies.

In bakery and pastry education, communication, teamwork, and leadership should therefore be developed within authentic production environments rather than treated as separate classroom topics. Students can rotate through roles involving 'mise en place', mixing, oven management, finishing, quality checking, inventory, and dispatch, while being assessed on communication, task handover, error reporting, coordination, and support for team members. Leadership can be demonstrated through production planning, task allocation, responding to production failures, and documenting corrective actions. Embedding these competencies within actual production activities makes transversal skills observable and allows assessment to move beyond generic group assignments towards evidence of workplace behavior.

Problem solving and analytical thinking also require deliberate curriculum attention. Research involving 831 Culinary Arts students from Malaysian Community Colleges reported a medium level of problem-solving skills and highlighted the need for learning environments that more effectively develop this capability (Techanamurthy et al., 2018). Although the study does not establish which instructional approaches produce improvement, it indicates that practical exposure alone should not be assumed to develop higher-order thinking automatically. Bakery and pastry programmes can make problem solving explicit through authentic

production challenges, including collapsed cakes, weak gluten development, over-fermentation, uneven browning, unstable emulsions, poor lamination, inappropriate moisture balance, or packaging-related quality problems. Students can be required to diagnose causes, select corrective actions, document outcomes, and justify their decisions. Such activities would transform problem solving from an abstract employability skill into an observable component of bakery practice.

Transversal competencies should consequently be assessed through authentic production performance. Assessment can consider not only the quality of the final product but also how students communicate, coordinate tasks, manage time, respond to unexpected problems, make decisions, and reflect on production outcomes. This approach would strengthen the integration between technical competence and workplace behavior and provide more meaningful evidence of students' occupational readiness.

Digital, Entrepreneurial, Halal and Sustainable Competencies

Digital and Industry 4.0 capabilities represent an increasingly important dimension of future-ready bakery and pastry education. A comparative study involving students in Indonesia and Malaysia reported intermediate digital competence, with information skills relatively stronger and problem-solving capabilities weaker (Universitas Pendidikan Indonesia & Kuntadi, 2022). However, because the participants were university students with industrial experience rather than Malaysian vocational-college bakery students, the findings should be regarded as an indication for curriculum development rather than a direct measure of bakery students' digital readiness. More recent Malaysian TVET research identifies Industry 4.0 competency domains encompassing cognitive, operational-work, individual, and professionalism capabilities (Mazlan et al., 2026). Related research involving academic and industry experts further identifies multiple competency components across these domains, reinforcing the importance of professional and individual capabilities alongside technical and digital knowledge (Mazlan et al., 2025). Within bakery and pastry education, these competencies can be developed through digital recipe management, production scheduling, inventory monitoring, costing systems, online ordering, digital marketing, data-informed quality control, and continuous professional learning. Digitalization should therefore be used purposefully to improve production, decision making, and employability rather than introduced simply as an additional technological component.

Entrepreneurship is similarly important because bakery and pastry skills can support both wage employment and self-employment. Malaysian vocational curriculum research highlights the importance of generic capabilities such as communication and creativity, while bakery-related research proposes the integration of technical, soft, and entrepreneurial competencies through a Bakepreneurship learning model (Mansor & Rus, 2020; Syarbini et al., 2020). Programme content could therefore include product costing, purchasing, pricing, branding, packaging, customer analysis, digital marketing, online sales, and small-business planning. These activities would allow students to connect production skills with the commercial decisions required to establish and sustain a bakery-related enterprise.

Halal assurance and sustainability should also be developed as practical occupational competencies rather than isolated theoretical topics. Recent Malaysian evidence on the halal profession indicates demand for combinations of technical, managerial, practical, digital, and

product-innovation competencies (Abidin et al., 2026). In bakery and pastry education, these competencies can be translated into ingredient verification, supplier documentation, contamination control, halal traceability, labelling, and appropriate handling practices. Sustainability can similarly be incorporated through food-waste reduction, ingredient-yield optimization, energy management, packaging decisions, waste segregation, and responsible sourcing. Students could be required to justify production decisions according to their implications for product quality, cost, safety, halal compliance, and environmental impact.

Digital, entrepreneurial, halal, and sustainability competencies should be integrated into bakery and pastry production rather than added as separate content areas. Students can use digital systems to manage production and marketing, apply entrepreneurial thinking to product development, incorporate halal requirements into ingredient and process decisions, and evaluate the environmental consequences of production practices. Such integration would enable students to demonstrate their ability not only to produce bakery products but also to use technology, create value, manage resources, respond to market needs, meet halal and quality requirements, and operate more sustainably. The limited bakery-specific evidence currently available in Malaysian vocational colleges further indicates the need for future research to determine how effectively these competencies are developed and demonstrated in authentic educational and workplace settings.

Pedagogy and Industry Linkage

Pedagogical Approaches and Assessment for Bakery and Pastry Competence

Bakery and pastry competence is developed through repeated, guided, and increasingly independent practice rather than theoretical instruction alone. Malaysian evidence indicates that practical learning can improve psychomotor performance, knowledge, and learner confidence (Rahman et al., 2016). Comparative evidence from vocational culinary education in Cyprus similarly emphasizes demonstration, learning by doing, repetition, and adaptation of teaching approaches according to learner needs (Anastasiou & Marinos, 2017). Although the latter study was conducted outside Malaysia, it reinforces the pedagogical principle that craft-based competencies require sustained opportunities for practice. For bakery and pastry programmes, effective instruction should therefore follow a cycle of demonstration, guided practice, feedback, repetition, and independent production. Teachers should make tacit occupational knowledge explicit by explaining judgements related to dough consistency, fermentation readiness, temperature control, finishing quality, sanitation, and product defects. Adequate practice time is particularly important because demonstration without sufficient opportunities for students to perform may create an appearance of learning without establishing reliable competence, while unguided repetition may reinforce incorrect techniques.

Teacher competency is an important component of this pedagogical process. Among Malaysian Culinary Arts students, teacher competency and workplace skills were reported at moderate levels and were positively correlated (Mohamed et al., 2021). Although the correlational design does not establish causality, the finding highlights the potential role of teachers in connecting classroom learning with workplace expectations. Teachers therefore require not only technical expertise but also the ability to facilitate problem solving, provide meaningful feedback, demonstrate industry practices, and assess authentic performance. Professional development should consequently include opportunities for teachers to update

occupational knowledge, engage with industry, and strengthen contemporary pedagogical and assessment practices.

Assessment should reinforce rather than contradict this practice-oriented approach. Evidence from food-service production-unit learning demonstrates the value of performance and product monitoring, although the absence of a standardized instructional framework may contribute to variation in learning outcomes (Lasmi & Nawawi, 2022). A future-oriented bakery and pastry curriculum should therefore assess both process and product, including technical execution, product consistency, food safety, teamwork, problem solving, documentation, and enterprise-related decisions. Common assessment criteria and performance rubrics could provide greater consistency across institutions while allowing teachers to adapt products and production activities to local industry contexts. Multiple assessment opportunities across different products and production conditions would also provide stronger evidence of competence than a single practical task.

Work-Based Learning and Industry Linkage

Work-based learning and industrial training provide an important mechanism for transferring classroom competencies into authentic occupational settings. Malaysian vocational colleges already engage industry through on-the-job training, programme quality assurance, human-capital development, and professional-sharing activities (Sappar et al., 2024). Student-focused research has also reported positive perceptions of industrial training, with vocational catering students indicating high levels of knowledge, understanding, and application and viewing industrial exposure as beneficial to academic and future preparation (Rahman, 2022). Similarly, culinary students have reported improvements in knowledge, confidence, and performance following internship experiences (Sahak et al., 2017). However, these findings are predominantly based on perceptions and self-reported outcomes and therefore provide limited evidence of the extent to which industrial training produces objectively demonstrated occupational competence. For bakery and pastry education, work-based learning should consequently be structured around clearly defined learning outcomes, supervised practice, workplace assessment, reflective documentation, and systematic feedback from industry supervisors.

Industry participation should also extend beyond providing internship placements towards curriculum co-design and continuous curriculum improvement. Malaysian hospitality employers have identified workplace, personal-effectiveness, management, and academic competencies through a Delphi process (Shariff & Razak, 2021). These competency domains can inform bakery and pastry learning outcomes, practical tasks, assessment criteria, equipment requirements, and workplace expectations. Industry representatives could contribute to curriculum review, validate occupational standards, provide authentic production briefs, review equipment and technologies, moderate practical assessments, and evaluate student products. Such involvement would strengthen the alignment between vocational-college learning and the competencies expected in employment and enterprise environments.

However, sustainable industry collaboration requires institutional structures rather than reliance on individual relationships. Evidence from the Malaysian 2u2i hospitality programme indicates that university–industry collaboration can encounter bureaucratic processes, time

constraints, approval delays, and additional costs (Yusof et al., 2020). Although the programme operates at higher-education level, these organizational challenges have implications for vocational education. Effective partnerships therefore require clearly defined roles, dedicated coordination, manageable administrative procedures, appropriate funding, and shared accountability. Without these conditions, industry engagement may remain episodic and vary considerably across institutions.

Effective bakery and pastry education can be conceptualized through a practice–feedback–industry cycle. Teachers demonstrate and guide authentic production, students receive repeated opportunities to practice and improve, assessment captures observable process and product evidence, and industry partners validate the relevance of competencies to current workplace requirements. Evidence generated through these activities can then inform subsequent curriculum revision, teacher development, assessment improvement, and industry collaboration. Such an integrated approach would strengthen the transition from classroom practice to occupational capability and support the continued responsiveness of bakery and pastry education to technological, industrial, entrepreneurial, and employment changes.

Implementation Issues and Equity

Institutional Resources and Practice Conditions

The development of occupational competence in bakery and pastry is strongly influenced by the institutional conditions in which learning takes place. Competency-based practical education requires adequate facilities, ingredients, equipment, supervision, and protected practice time. Evidence from a study of Bread and Pastry Production learners in the Philippines found that practical performance exceeded written performance, while inadequate tools, inconsistent ingredients, and limited laboratory time constrained competency development (García et al., 2026). Although the study was conducted outside Malaysia and therefore cannot be used to estimate Malaysian conditions, it illustrates an important programme mechanism: occupational competence cannot be developed consistently without sufficient opportunities for repeated and supervised practice.

Malaysian evidence similarly indicates moderate levels of workplace skills and teacher competency among Culinary Arts students, suggesting that instructional quality and learning conditions need to be considered together (Mohamed et al., 2021). Strong teaching alone may not compensate for inadequate ovens, mixers, refrigeration, workstations, measurement equipment, ingredients, maintenance, or student-to-equipment ratios. Curriculum transformation should therefore extend beyond revising learning outcomes to include systematic facility audits, equipment availability, ingredient provision, maintenance schedules, appropriate student-to-equipment ratios, and protected practice time. These conditions are particularly important in bakery and pastry education because repeated production is required to develop consistency, speed, sensory judgement, and the ability to respond to variations in ingredients and production conditions.

Institutional capacity should also support teachers in implementing future-oriented curriculum content. Malaysian research has reported levels of readiness, understanding, and implementation of Industry 4.0 among TVET lecturers, while more recent research involving Malaysian Community College lecturers identified moderate use of digital teaching tools,

limited adoption of advanced Industry 4.0 technologies, and variation in institutional readiness across regions and programme types (Zulnaidi & Majid, 2020; Rasid et al., 2025). Because these studies involve different populations and measurement approaches, they should not be interpreted as evidence of a direct longitudinal trend. Rather, they demonstrate that teacher readiness depends on the depth and type of implementation being measured. For bakery and pastry teachers, professional development should connect digital pedagogy with authentic occupational applications, including digital production records, recipe scaling, inventory and costing systems, online customer management, product marketing, food-safety documentation, and data-informed quality improvement. Opportunities for teachers to update industrial knowledge and participate in joint assessment with industry practitioners could further strengthen programme implementation.

Assessment Validity and Quality Assurance

Assessment validity is critical because occupational competence cannot be established reliably through self-report alone. A substantial proportion of Malaysian studies examining employability, workplace skills, problem solving, industrial training, and digital readiness rely on questionnaire-based evidence (Ahmad et al., 2017; Mohamed et al., 2021; Rahman, 2022; Techanamurthy et al., 2018; Universitas Pendidikan Indonesia & Kuntadi, 2022). Such approaches are useful for understanding perceptions and identifying broad competency patterns, but perceived competence may not correspond to demonstrated occupational performance. The contrast between high perceived employability and more specific gaps in teamwork, leadership, technical, and other competency domains illustrates the importance of using multiple forms of evidence (Ahmad et al., 2017; Kenayathulla et al., 2019).

A stronger bakery and pastry assessment system should therefore combine written knowledge assessment with direct observation, product-based evidence, process documentation, workplace-supervisor evaluations, and graduate outcomes. Assessment should distinguish self-efficacy from demonstrated competence, task completion from consistency, and classroom performance from workplace performance. Practical assessment should also capture both the production process and the final product, including technical accuracy, hygiene, quality control, problem solving, teamwork, resource management, and corrective action.

Quality assurance mechanisms are necessary to ensure that competency standards are applied consistently across vocational colleges. Common task specifications, explicit performance criteria, trained assessors, moderation, and opportunities to demonstrate competence across multiple products or production conditions could improve assessment reliability. Industry representatives could also contribute to the validation of assessment standards and the review of student products. Such mechanisms would strengthen the credibility of competency claims and provide more reliable evidence of whether programme outcomes correspond to occupational expectations.

Equity and Differentiated Learning Opportunities

Curriculum transformation should also recognize that students do not enter bakery and pastry programmes with identical experiences, abilities, resources, or learning needs. Research involving Malaysian Culinary Arts and bakery-pastry students indicates that factors such as student interest, parental influence, and career considerations influence programme

selection (Tukiran et al., 2021). Such differences are relevant because prior exposure to practical activities may influence students' starting points and progression through competency-based learning.

Evidence from a Malaysian pastry pilot involving special-needs learners further demonstrates the importance of instructor support, modular learning, appropriate facilities, and realistic time allocation, particularly when learners require additional time to complete competency modules (Ahmad et al., 2020). This suggests that a single high-intensity instructional model may not provide equitable opportunities for all learners. Differentiated pacing, accessible instructional materials, structured scaffolding, appropriate equipment, clear demonstrations, and additional guided practice may be required to support learners with different levels of prior knowledge and ability.

Equity should, however, be balanced with the maintenance of consistent occupational standards. Differentiation should modify the pathway and support provided to learners, rather than lowering the competency expected at the point of achievement. This principle is particularly important in bakery and pastry education, where food safety, product quality, hygiene, and technical accuracy are directly connected to workplace and consumer requirements.

The evidence indicates that curriculum transformation cannot be achieved through content revision alone. The effectiveness of future-ready bakery and pastry education depends on the interaction among curriculum content, institutional resources, practice time, assessment quality, teacher capability, and equitable access to learning opportunities. A transformed programme should establish adequate conditions for authentic practice, use multiple forms of evidence to verify competence, continuously develop teacher capability, and provide differentiated learning pathways while maintaining consistent occupational standards. Such an institutional foundation is essential for ensuring that intended future competencies become observable, transferable, and sustainable workplace capabilities rather than remaining stated outcomes within the curriculum.

Transformation Agenda and Evaluation

Future-Ready Competency Framework for Bakery and Pastry Education

The transformation of bakery and pastry education requires a clearly structured competency architecture that connects technical production with broader occupational and future-ready capabilities. Rather than treating competence as the mastery of recipes, programme content should be organized into four interconnected domains: technical production, safe and sustainable operation, transversal workplace performance, and enterprise and digital capability. Technical competencies should encompass ingredient functions, formulation, scaling, mixing, fermentation, baking, finishing, storage, packaging, and defect diagnosis. Safe and sustainable operation should incorporate hygiene, food safety, quality control, waste management, energy use, halal assurance where applicable, and production documentation. Transversal competencies should include communication, teamwork, leadership, problem solving, time management, ethical practice, adaptability, and lifelong learning. Enterprise and digital capabilities should address costing, purchasing, product innovation, branding, e-commerce, data use, and customer feedback. This structure is consistent with Malaysian hospitality and culinary competency frameworks that position technical skills alongside

workplace, personal, management, and professional capabilities (Shariff & Razak, 2021; Suhairom et al., 2016, 2019).

The competency domains should be translated into levelled performance indicators rather than presented simply as lists of desirable attributes. Each competency should specify the expected performance context, standard, evidence, and degree of learner independence. For example, product development should progress from following an established formulation to modifying a recipe, testing the resulting product, analyzing defects, calculating production costs, and justifying reformulation decisions. Similarly, problem-solving competency should progress from identifying common production defects to independently diagnosing complex production problems and implementing appropriate corrective actions. Such progression would enable curriculum content to reflect increasing occupational complexity and provide a clearer relationship between learning outcomes and demonstrated competence.

Authentic Production, Pedagogy and Work-Based Learning

Authentic production can provide the learning environment through which the proposed competency domains are integrated. Evidence from vocational production-unit learning demonstrates that real business activities can simultaneously develop food safety, discipline, independence, creativity, communication, decision making, time management, and leadership (Evawati, 2020). Malaysian vocational curriculum research also demonstrates the feasibility of systematic design-and-development approaches for integrating generic skills within vocational education (Mansor & Rus, 2020). A bakery teaching-factory approach could therefore place students in supervised production environments where they respond to authentic customer or industry briefs, calculate yields and costs, plan production schedules, apply food-safety controls, produce and evaluate products, manage waste, and conduct post-production reviews.

Such production-based learning should remain fundamentally educational rather than becoming a commercial operation dependent on student labor. Teachers should retain responsibility for learning progression, supervision, assessment, and equitable participation, while industry partners could contribute authentic briefs, occupational standards, workplace expectations, and feedback. Learning activities should progress from teacher demonstration and guided practice towards collaborative production and increasingly independent performance. This approach would enable students to develop technical precision while simultaneously applying communication, teamwork, problem solving, decision making, and time-management skills in realistic production conditions.

Work-based learning should further strengthen the relationship between vocational preparation and occupational practice. Existing Malaysian industry-collaboration practices involving on-the-job training, programme quality assurance, human-capital development, and professional sharing provide potential institutional mechanisms for this purpose (Sappar et al., 2024). Industry participation should extend beyond placement opportunities to include curriculum review, validation of competency standards, authentic production briefs, workplace assessment, equipment and technology updates, and feedback on graduate performance. Through such collaboration, the relevance of programme content can be reviewed against changing occupational practices rather than being determined solely within the educational institution.

Digital, Sustainable and Entrepreneurial Transformation

Digitalization and sustainability should be integrated into production-based learning without displacing the craft foundations of bakery and pastry. Evidence involving Malaysian and Indonesian TVET students indicates the importance of digital competence, while Malaysian Industry 4.0 research highlights cognitive, operational, individual, and professional capabilities as components of future work readiness (Universitas Pendidikan Indonesia & Kuntadi, 2022; Mazlan et al., 2026). Within bakery education, digital applications could include recipe management, production scheduling, inventory and costing systems, online ordering, digital marketing, production documentation, customer management, and data-based quality improvement. Students should nevertheless continue to develop sensory judgement, manual control, product observation, and other embodied craft capabilities that cannot be fully replaced by digital tools.

Sustainability should similarly be embedded within everyday production decisions rather than introduced as an isolated curriculum topic. Students could be required to consider energy-efficient production scheduling, ingredient-yield optimization, surplus-food reduction, packaging choices, waste segregation, local sourcing, and product reformulation. Malaysian evidence on green-skill development suggests that required levels of green technology competency may exceed current readiness, reinforcing the need for deliberate curriculum development (Ramli et al., 2020). Sustainability therefore needs to be connected directly to production quality, cost, safety, and environmental outcomes.

Entrepreneurial capability should form another component of this transformation. Bakery and pastry graduates may enter hotels, restaurants, cafés, bakeries, food manufacturing, catering, retail, or self-employment. Programme content should therefore provide opportunities to develop costing, purchasing, pricing, branding, customer communication, product innovation, digital promotion, e-commerce, and basic business decision making. These competencies could be developed through product-development projects in which students are required to design a product, calculate its cost and selling price, identify a target market, develop packaging and promotional materials, and evaluate customer feedback. In this way, digital, sustainability, and entrepreneurship competencies would be demonstrated through authentic production rather than taught as disconnected theoretical components.

Implementation and Continuous Evaluation Cycle

Implementation should be supported through a staged and cyclical process linking curriculum design, teaching, resources, assessment, industry engagement, and graduate outcomes. First, vocational colleges and industry partners should jointly map occupational tasks and establish relevant performance standards. Second, teachers should redesign modules around repeated practical work, authentic production problems, and integrated enterprise and digital activities. Third, facilities, equipment, ingredients, and timetables should be reviewed to ensure sufficient opportunities for competency development. Fourth, assessment evidence should be moderated to promote consistency across classes and institutions. Finally, graduate, employer, internship-supervisor, and enterprise outcomes should be systematically reviewed and used to inform subsequent curriculum revisions. This creates a continuous cycle in which curriculum content is adjusted in response to evidence from actual occupational practice.

Evaluation should extend beyond student satisfaction or general perceptions of programme quality. Short-term indicators could include observed technical performance, product consistency, hygiene compliance, problem-solving quality, teamwork, digital-task performance, and resource utilization. Medium-term indicators could include internship-supervisor assessments, competency certification, employment, employment retention, career progression, business formation, and employer-reported competency gaps. Where feasible, longer-term evidence should examine whether graduates sustain and apply their competencies after entering employment or entrepreneurship. Multiple sources of evidence would provide a stronger basis for determining whether intended competencies have been translated into actual occupational capability.

The proposed transformation positions bakery and pastry education as a dynamic competency-development system rather than a recipe-based technical programme. Its central principle is that future-ready competence emerges when technical mastery, safe and sustainable production, transversal workplace capabilities, and digital and entrepreneurial skills are developed together through authentic practice. The proposed approach therefore connects what students learn, practice, demonstrate, and ultimately apply in employment or enterprise. At the same time, the cyclical use of industry feedback, performance evidence, and graduate outcomes provides a mechanism for keeping programme content responsive to technological, industrial, environmental, and societal changes.

Synthesis of Key Issues and Challenges in Bakery and Pastry Programme

The literature reviewed indicates that the challenges facing the Bakery and Pastry Programme extend beyond the adequacy of technical skills and involve interconnected issues related to curriculum relevance, competency development, pedagogy, assessment, institutional capacity, industry engagement, and future readiness. Although existing studies provide evidence of strengths in practical learning and occupational preparation, gaps remain in the integration of transversal, digital, entrepreneurial, sustainability, halal, and problem-solving competencies within authentic bakery and pastry education. Concerns have also been identified regarding the availability of facilities and practice time, consistency of assessment, teacher readiness, industry–institution collaboration, and equitable learning opportunities. Table 1 summarizes the key issues and challenges identified from the literature and highlights their implications for the transformation of the Bakery and Pastry Programme in Malaysian vocational colleges.

Table 1

Summary of Key Issues and Challenges in Bakery and Pastry Education

Major Challenge Area	Core Issues
1. Curriculum and Industry Alignment	Outdated or insufficiently industry-responsive content; weak integration of occupational standards; limited systematic industry participation.
2. Competency Development	Stronger emphasis on technical production than problem solving, teamwork, leadership, digital, entrepreneurial, sustainability, and halal competencies.
3. Teaching, Practice and Assessment	Insufficient practice time and resources; variation in teacher capability; reliance on self-report; limited authentic performance assessment.

4. Institutional and Equity Conditions	Uneven facilities, equipment, ingredients, teacher readiness, learning opportunities, and support for students with different needs.
5. Future Readiness and Continuous Transformation	Limited integration of digital, green, entrepreneurial and emerging occupational competencies; insufficient graduate and employer evidence to drive continuous curriculum renewal.

Taken together, these issues indicate that the transformation of bakery and pastry education requires a shift from a predominantly technical and production-oriented curriculum towards an integrated competency-development approach. The challenge is not simply to introduce additional content, but to strengthen the alignment between what students learn, practice, demonstrate, and subsequently apply in the workplace or enterprise. This requires simultaneous attention to curriculum content, authentic practice, assessment, institutional conditions, teacher capability, industry engagement, and equitable access to learning opportunities. The identified challenges therefore provide the basis for proposing a future-ready competency framework and a systematic transformation agenda for bakery and pastry education in Malaysian vocational colleges.

Conclusion

Malaysian bakery and pastry education provides a credible foundation for developing skilled learners through hands-on practice, instructor guidance, practical learning, and industry collaboration. However, the literature indicates incomplete alignment between programme content, authentic workplace practice, assessment, and the competencies required in a rapidly changing food and hospitality industry. Much of the Malaysian evidence also combines bakery with broader culinary or hospitality education, limiting the extent to which bakery-specific occupational competencies can be established. Greater attention is therefore needed to distinguish technical production competencies from broader workplace capabilities and to assess actual performance through product-based and workplace-based evidence rather than relying predominantly on self-reported competence. Consistency is also required in translating industry expectations into curriculum content, authentic production tasks, and competency standards across vocational colleges.

The literature further highlights limited evidence on whether competencies developed during vocational education are sustained and transferred beyond the classroom. Existing studies provide insufficient evidence on graduate employment stability, career progression, enterprise development, and employer perceptions of graduate capability. Bakery-specific and longitudinal research is therefore needed to examine competency development across the transition from vocational education to internship, employment, and entrepreneurship. Employer and workplace-supervisor feedback should be incorporated to determine whether programme content remains aligned with occupational standards and changing industry requirements. Future assessment should consequently integrate teacher observation, product performance, process evidence, workplace-supervisor ratings, and graduate outcomes to strengthen the verification of occupational competence.

Future-ready bakery and pastry education should extend beyond conventional technical production to incorporate digital, green, halal, entrepreneurial, innovation, and employability competencies. Digital recipe management, costing and inventory systems, online marketing, sustainable production, food-waste reduction, energy management, halal traceability,

product innovation, and small-business development should be embedded within authentic production and enterprise activities rather than treated as separate curriculum components. At the same time, curriculum transformation should account for differences in learner abilities, prior experience, access to equipment, practice time, institutional resources, and industry exposure. Appropriate facilities, instructor support, flexible delivery, and differentiated learning opportunities should therefore be provided while maintaining consistent occupational standards.

Transforming Malaysian bakery and pastry education requires more than adding new technologies or technical content. It requires systematic realignment of programme content, authentic practice, industry expectations, assessment, institutional resources, and graduate outcomes. Employers and educators should collaboratively identify relevant competencies, while vocational colleges should provide sufficient resources and repeated opportunities for authentic production. Assessment should capture both process and product performance, with evidence from graduates, employers, and workplace supervisors informing continuous curriculum improvement. Through this cyclical approach, bakery and pastry education can progress towards an integrated competency model encompassing technical mastery, food safety, quality assurance, critical thinking, problem solving, teamwork, digital fluency, entrepreneurship, halal assurance, sustainability, adaptability, and lifelong learning. Further bakery-specific, longitudinal, and employer-validated research is needed to establish how effectively these competencies are developed, demonstrated, and sustained across the transition into employment and enterprise.

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