

FROM FORMULAS TO FUN: *CC FACTS RACE* GAMIFIES FOOD AND BEVERAGE COST CONTROL LEARNING

Nurul Fazira Mohamad Noor Afandi¹, Dayang Shahiera Ellayana Shamsuzanni¹, Nur Farhanis Faizal¹, Krissana Sommar¹, Zahirah Zulkifli¹, Siti Najjah Sanusi¹, Roseline Anak Kok¹, Wei Boon Quah^{2*}

¹Department of Tourism and Hospitality, Politeknik Tuanku Syed Sirajuddin, Pauh Putra, 02600 Arau Perlis, Malaysia

²Unit Hotel Operation, Sungai Petani Community College, No. 77, Lengkok Cempaka 1, Pusat Bandar Amanjaya, 08000 Sungai Petani, Kedah, Malaysia

*Corresponding author: quah@kkspe.edu.my

Abstract

Traditional pedagogical approaches frequently encounter obstacles, including limited student engagement and challenges in retaining complex formulas. This study investigates the efficacy of an educational online game, *CC Facts Race*, designed to enhance comprehension of Food and Beverage (F&B) Cost Control concepts. The research was conducted at Polytechnic of Tuanku Syed Sirajuddin in Perlis, Malaysia, involving 150 participants from the Diploma in Resort Management (DHR) and Diploma in Foodservice (DHF) programs. Data were gathered through questionnaires, and a descriptive analysis was employed to evaluate the findings. The results indicate that students rated *CC Facts Race* highly for its usability, player experience, and overall satisfaction. The game was perceived as accessible, engaging, and effective in improving both understanding and retention of F&B cost control principles. This study concludes that *CC Facts Race* represents a valuable supplement to educational curricula, providing an interactive and enjoyable learning platform. Future research could explore longitudinal effects on knowledge retention and instructors' perspectives regarding the integration of *CC Facts Race* into teaching practices.

Keywords: Educational online games, Food and Beverage Cost Control, Student Engagement, Learning Outcomes, Gamification

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Introduction

Within the evolving context of the hospitality industry, proficiency in managing food and beverage (F&B) costs represents a fundamental competency for students preparing for careers in this domain. The ability to comprehend and apply intricate cost control principles, including fixed and variable costs, break-even analysis, and profit margins, is indispensable for maintaining the financial viability of food service establishments (Niu et al., 2021). Nevertheless, conventional instructional approaches, which predominantly rely on lectures and textbooks, have proven inadequate in fostering student engagement and promoting a thorough understanding of these concepts (Rosenthal et al., 2024). To address these shortcomings, this study introduces *CC Facts Race*, an educational online game designed to deliver an interactive and compelling learning experience that mirrors real-world cost control scenarios.

Educational games have increasingly been acknowledged as valuable instruments for enhancing learning processes. In the hospitality sector, mastery of F&B cost control is vital for ensuring both profitability and long-term sustainability. Yet, traditional pedagogical methods frequently fail to capture students' interest, resulting in challenges in grasping essential cost management principles (Babajide et al., 2015). In response, *CC Facts Race* was developed as an innovative educational tool to heighten student engagement, motivation, and comprehension of cost control concepts within the hospitality field.

The efficacy of game-based learning is well-documented, particularly its ability to bolster motivation, enhance problem-solving abilities, and improve knowledge retention (Deng et al., 2020). Evidence suggests that interactive educational tools significantly enhance students' ability to master complex financial and operational concepts by embedding authentic scenarios within engaging gameplay frameworks (Adipat et al., 2021). Consequently, the integration of gamification into F&B cost control education holds the potential to elevate academic outcomes and facilitate practical application in professional hospitality contexts.

Food cost control constitutes an essential element of hospitality management; however, many students encounter difficulties in mastering its intricacies (Rosenthal et al., 2024). Moreover, a significant number of learners struggle with performing accurate calculations, a core competency in this domain (Edeh et al., 2019). Compounding this issue, the comprehension and retention of necessary formulas present additional challenges, which may hinder academic success (Kaniawati et al., 2023). These obstacles often result in decreased academic performance and diminished self-confidence among students (Ningrum & Listyani, 2022). To address these difficulties, researchers have proposed embedding food cost control formulas within an engaging educational online game. This innovative approach aims to reframe a conventionally challenging subject into a more appealing and memorable learning experience, thereby enabling students to overcome these challenges and achieve academic success (Hussein & Abdirahman, 2024). Furthermore, existing literature asserts that interactive learning tools, such as educational games, substantially enhance students' comprehension and retention of complex topics (Aragonez et al., 2021; HajiMoradkhani et al., 2023). Accordingly, the incorporation of such tools into the curriculum could effectively bridge theoretical understanding and practical application, making the educational process both more impactful and enjoyable for learners.

The primary objective of this study is to evaluate the effectiveness of the *CC Facts Race* educational online game in improving students' understanding of F&B cost control concepts. Specifically, the study aims to:

1. Identify the usability of the *CC Facts Race* educational online game.
2. Assess the player's experience after engaging with the game.
3. Determine the level of player satisfaction with the game.

Numerous studies emphasize the pivotal roles of usability, player experience, and satisfaction in determining the success of educational online games, offering a solid foundation for evaluating tools like *CC Facts Race*. Usability involves more than technical operability; it encompasses playability, pedagogical value, and mobility. Al Fatta et al. (2018) argue that intuitive design is essential for maintaining learner focus, while Ninaus and Nebel (2021) highlight the value of real-time analytics to refine and adapt usability features. In terms of player experience, Cavus et al. (2023) suggest that engagement is highest when games provide clear objectives, manageable challenges, and visually stimulating environments. Hainey et al. (2016) warn, however, that overly complex game mechanics may hinder learning, emphasizing the need for balance. Satisfaction acts as the unifying construct within gamified learning, linking usability and engagement to positive educational outcomes. Dahalan et al. (2024) found that streamlined interfaces contribute to improved skill retention in vocational settings, while Subhash and Cudney (2018) reported that enjoyable user experiences enhance long-term knowledge retention. Similarly, Ruiz-Navas et al. (2024) noted that engaging game-based environments can motivate diverse learners, though accessibility barriers remain a concern (Salvador-Ullauri et al., 2020).

To strengthen the global relevance of this discussion, more recent studies from Western contexts have been incorporated. For example, Papadakis et al. (2022) demonstrated that gamification significantly improves motivation and science learning outcomes among primary students in Europe. Expanding on this, Zourmpakis et al. (2023) explored adaptive gamification and confirmed that specific design elements positively influence learners' motivation. Papadakis et al. (2020) also evaluated the "ThimelEdu" educational game and emphasized the importance of iterative game

testing for optimizing the learning process. Additionally, Karakose et al. (2023) examined psychological and motivational factors in gamified teacher training, suggesting that gamification can effectively support confidence and professional identity development. Collectively, these findings reinforce that well-designed educational games, when grounded in motivational theory and adapted for local contexts, can serve as powerful tools for enhancing both student engagement and learning outcomes in hospitality education and beyond.

Self-Determination Theory (SDT), developed by Deci and Ryan (1985), posits that intrinsic motivation is fostered when three basic psychological needs are satisfied: autonomy, competence, and relatedness. Accordingly, *CC Facts Race* was developed to promote autonomy by allowing learners to control their pace and progress through the game independently; to build competence by providing clear objectives, achievable challenges, and immediate feedback that reinforce mastery of food and beverage cost control concepts; and to support relatedness by embedding real-world hospitality scenarios that students can connect with, thereby increasing the relevance and authenticity of the learning experience (Ryan & Deci, 2000).

Methods

The study employed a quantitative research design. The population for this study consists of Diploma in Resort Management (DHR) and Diploma in Foodservice (DHF) students in higher education institutions in Malaysia, specifically at Polytechnic of Tuanku Syed Sirajuddin. For a population size of 190, the Krejcie and Morgan (1970) table suggests a recommended sample size of 128. However, the researchers chose a sample size of 150, which provides a sufficient representation of the population and maintains a good level of accuracy in the study. To ensure that the sample is representative of the population, the researchers use a systematic sampling method. This technique allows every member of the population an equal chance of being selected, thereby minimizing bias and enhancing the reliability of the results. To determine the sample size, the researchers conducted a process of randomly selecting names from a comprehensive list that includes students from both the DHR and DHF classes. This approach involved creating a list of all eligible participants from these classes and then utilizing a random number generator to ensure that the selection was entirely impartial. By following this method, the researchers aimed to capture a wide range of perspectives within the population, ensuring that the findings would be valid and generalizable.

The instrument used is a closed ended questionnaire. The questionnaire was adapted from established tools developed by Petri and Von Wangenheim (2019) and Von Wangenheim et al., (2020), originally used for evaluating gamified learning experiences. The items were carefully contextualized for Food and Beverage (F&B) Cost Control by modifying examples, terminologies, and scenarios to reflect hospitality-specific content and skills. This adaptation ensures construct validity and contextual relevance (DeVellis, 2016). As for the instrumentation, a self-administered questionnaire was designed properly into three parts consisting of Section A: Usability, Section, B: Player Experience, Section C: Satisfaction. The items for each section were adapted from Petri and Von Wangenheim (2019) and Von Wangenheim et al., (2020) research that similarly related to the study. A five-point Likert response format (ranging from strongly agree 5 to strongly disagree) was adapted in this study. The respondents were given 15 minutes to play the *CC Facts Race* educational online game before answering the questionnaire. The questionnaire link was shared in a WhatsApp group featuring the selected participants. Before distributing the questionnaire, the researchers seek permission from each respondent, providing a brief overview of the purpose of the study to encourage participation to participate in the study. After the respondents consented, they received a self-administered questionnaire to complete at their convenience. This self-administered questionnaire approach was selected due to its practicality, efficiency, and ability to capture immediate student perceptions following the game-based learning activity.

Self-administered questionnaires are commonly used in educational technology research as they allow respondents to reflect independently, reduce social desirability bias, and support large-sample data collection within classroom-based settings (Creswell & Creswell, 2018). Additionally, the structured

nature of the questionnaire enabled consistency in data measurement across usability, experience, and satisfaction dimensions. While researchers acknowledge the limitations of relying solely on quantitative data, the current study was designed as a preliminary investigation. As recommended, researchers have suggested that future research incorporate mixed methods, including interviews or classroom observations, to provide richer, triangulated insights. Data were analysed using descriptive statistics, including mean scores and standard deviations. A pilot test of the questionnaire was conducted with 30 respondents to evaluate the feasibility, time, cost, and effectiveness of a research method before the full-scale study was implemented. It helped identify any issues in the study design and allowed researchers to make necessary adjustments to improve the overall quality of the research. Pilot testing was to examine the validity of each item in the questionnaire. The reliability value for usability is .863, while the reliability for player experience is .940, and for satisfaction is .911. A frequently cited acceptable range of Cronbach's alpha is a value of 0.70 or above. This is derived from the work of (Nunnally, 1978).

Ethical Considerations

Prior to participation, all respondents were informed about the purpose of the study, the voluntary nature of their involvement, and their right to withdraw at any time without consequence. Informed consent was obtained from all respondents prior to their participation. No personal identifiers were collected, ensuring respondent anonymity.

Result and Discussion

Among all respondents, the number of females is higher, making up 65.3% of the total sample, while males represent only 34.7%. This indicates that there were significantly more female respondents than male respondents in this study. The majority of respondents were 20 years old, comprising 42% of the total sample. The second largest age group was 19 years old, making up 24% of respondents. Other age groups had smaller percentages, with the smallest being 25 years old, representing only 0.7%. This distribution shows that younger age groups, especially those around 19 and 20 years, dominate the sample. A large majority of respondents were Malay, accounting for 92% of the sample. This is followed by Indian respondents, who made up 6.7%, while other races constituted only 1.3%. This data suggests that Malay respondents make up the majority of the study's participants. In terms of class, the largest group of respondents belonged to the DHF 4 class, with 26.7%. This is followed by the DH F5 class, which accounted for 20%, and the DHR 3 class with 18%. Smaller classes, such as DHR 2, had fewer respondents, with DHR2 being the lowest at 6.7%. This distribution shows a higher concentration in the DHF 4 and DHF 5 classes compared to others. Table 1 presents the respondents' demographic data.

Table 1. Respondents' demographic data

Gender	Frequency	Percent
Male	52	34.7
Female	98	65.3
Age		
18 - 20	101	67.3
21 - 23	45	30.0
> 23	4	2.7
Race		
Malay	138	92.0

Indian	10	6.7
Others	2	1.3
Class		
DHR 2	10	6.7
DHR 3	27	18.0
DHR 4	23	15.3
DHR 5	20	13.3
DHF 4	40	26.7
DHF 5	30	20.0

The findings from this study on the *CC Facts Race* educational online game reveal a consistently high level of usability, player experience, and satisfaction among students. These results, derived from three key tables (Tables 2, 3, and 4), offer insights into how this game supports learning food and beverage cost control while engaging students effectively.

Usability of *CC Facts Race*

Table 2 shows the usability of *CC Facts Race*, with a total mean score of 4.52 (SD = 0.658), rated as "High." Individual items, such as the game's attractive design (M = 4.51, SD = 0.712), ease of play (M = 4.55, SD = 0.747), and readable fonts (M = 4.56, SD = 0.660), all scored above 4.47, suggesting a user-friendly experience. This echoes the work of Al Fatta et al. (2018), who emphasized that usability in educational games hinges on playability and intuitive design. Students picking up the game quickly (M = 4.55, SD = 0.729) and finding rules clear (M = 4.47, SD = 0.766) support the findings of Ninaus and Nebel (2021), who found that adaptive, straightforward interfaces reduce cognitive overload, letting learners focus on content over mechanics. Compared to Dahalan et al. (2024), where complex navigation tanked motivation in vocational settings, *CC Facts Race* avoids such pitfalls, likely due to its streamlined design. Still, while the game shines in accessibility for most, Salvador-Ullauri et al. (2020) remind us that high usability scores do not necessary guarantee inclusivity for all learners, particularly those needing screen readers. This suggests a potential area for deeper investigation.

Table 2. The usability of *CC Facts Race* educational online game

No.	Items	Mean	Std. Deviation	Level
1.	<i>CC Facts Race</i> education design is attractive (interface, graphics, etc).	4.51	.712	High
2.	Students can learn to play <i>CC Facts Race</i> education game very quickly.	4.55	.729	High
3.	The <i>CC Facts Race</i> education rules are clear and easy to understand.	4.47	.766	High
4.	The <i>CC Facts Race</i> education game is easy to play.	4.55	.747	High
5.	The fonts (size and style) used in the game are easy to read.	4.56	.660	High
6.	Learning to play the <i>CC Facts Race</i> education game comes easily.	4.48	.702	High
TOTAL MEAN		4.52	.658	High

Player Experience After Playing the Game

Table 3 provides insights into player experience, with a total mean of 4.53 (SD = 0.512), also "High." Standout findings include the game being fun (M = 4.59, SD = 0.546), captivating from the start (M =

4.58, SD = 0.509), and boosting cost control motivation (M = 4.55, SD = 0.550). These align with Cavus et al. (2023), who linked clear goals and engaging visuals to sustained student interest across age groups. The game's challenges hitting the right difficulty (M = 4.51, SD = 0.621) and avoiding monotony (M = 4.45, SD = 0.756) mirror Hainey et al. (2019), who stressed balancing challenge with accessibility to keep learners hooked without overwhelming them. Skills such as calculation (M = 4.57, SD = 0.617) and memory enhancement (M = 4.53, SD = 0.587) also showed improvement, supporting the conclusions of Subhash and Cudney (2018), who found that gamified tasks can enhance practical retention in vocational education. The content aligning closely with course goals (M = 4.57, SD = 0.523) and resonating with student interests (M = 4.51, SD = 0.642) suggests that *CC Facts Race* achieves strong pedagogical alignment, which is a core usability principle according to Al Fatta et al. (2018). However, Ahmadov et al. (2024) caution that such alignment may not be consistent across culturally diverse learning environments, a nuance that may not be fully captured by this study's sample.

Table 3. Player experience after playing the game

No.	Items	Mean	Std. Deviation	Level
1.	The content and structure are very helpful in making students confident with <i>CC Facts Race</i> education game.	4.47	.662	High
2.	<i>CC Facts Race</i> education game offers a suitable level of challenge for students.	4.51	.621	High
3.	The game provides new challenges (offers new obstacles, situation, or variations) at an appropriate pace.	4.51	.663	High
4.	The game does not become monotonous as it progresses (repetitive or boring tasks).	4.45	.756	High
5.	Finishing the game tasks provided students with a fulfilling sense of accomplishments.	4.50	.599	High
6.	Students are pleased with what gained from the game.	4.53	.540	High
7.	The start of the game presents something captivating that can draw students' attention.	4.58	.509	High
8.	It is clear to students how the game content relates to the course.	4.57	.523	High
9.	<i>CC Facts Race</i> education online game increases students' motivation to study cost control food and beverage subject.	4.55	.550	High
10.	<i>CC Facts Race</i> education game is fun online game.	4.59	.546	High
11.	Playing <i>CC Facts Race</i> education game increase skills of calculation.	4.57	.617	High
12.	The varying questions enhance the capability of memories.	4.53	.587	High
13.	The contents of the <i>CC Facts Race</i> education game align perfectly with students' interests.	4.51	.642	High
14.	The activity contributed significantly to learning.	4.52	.632	High
15.	This game is the preferred method for learning compared to other ways.	4.52	.610	High
TOTAL MEAN		4.53	.512	High

Player Satisfaction Levels

Table 4 highlights satisfaction, with a total mean of 4.54 (SD = 0.563), again rated as "High." Top scores were recorded for better conceptual understanding (M = 4.57, SD = 0.617) and enjoyment of the learning process (M = 4.56, SD = 0.618), while the item on consolidating class learning scored the lowest, though still strong (M = 4.50, SD = 0.673). This enjoyment factor relates to the findings of Ruiz-Navas et al. (2024), who noted that usable, appealing games can engage even previously disengaged learners. The motivation to continue studying (M = 4.54, SD = 0.598) and general favorability toward gamification (M = 4.55, SD = 0.597) reflect the findings of Dahalan et al. (2024), where well-designed educational games fostered sustained interest in technical subjects. Students' willingness to recommend the game (M = 4.53, SD = 0.652) suggests a form of social buy-in, which Ruiz-Navas et al. (2024) identified as an underexplored dimension in educational game research. High satisfaction with learning outcomes (M = 4.52, SD = 0.683) further supports the conclusions of Cavus et al. (2023), showing that strong usability contributes not only to enjoyment but also to tangible educational benefits. However, the slightly lower score for consolidating class learning may suggest the need for a design improvement, such as incorporating more explicit connections to classroom theory, as recommended by Hainey et al. (2019),

to maximize learning impact.

Table 4. The level of player satisfaction

No.	Items	Mean	Std. Deviation	Level
1.	I think the <i>CC Facts Race</i> online game has helped me learn about the content of the subject.	4.52	.683	High
2.	I think that the <i>CC Facts Race</i> online game used has helped me to better understand concepts of the subject.	4.57	.617	High
3.	Following the levels of challenges in the <i>CC Facts Race</i> online game has helped me to consolidate what I learned in class.	4.50	.673	High
4.	The experience has motivated me to keep up with the subject and learn more about the topic.	4.54	.598	High
5.	I am in favour of Polytechnic studies using this approach (gamification) more in other subjects.	4.55	.597	High
6.	I would recommend this experience to other students.	4.53	.652	High
7.	I enjoyed playing the <i>CC Facts Race</i> online game while learning.	4.56	.618	High
TOTAL MEAN		4.54	.563	High

Limitations and Areas for Improvement

Despite the encouraging results regarding usability, engagement, and satisfaction, this study is not without limitations. First, there is a potential over-reliance on gamification, which may lead students to engage more with the gaming mechanics than with the intended learning objectives. Educators must strike a balance between entertainment and pedagogy to ensure learning outcomes remain the primary focus. Second, while the game design was intuitive for most users, it may present accessibility challenges for learners with disabilities—such as those requiring screen readers, alternative input devices, or simplified visuals (Salvador-Ullauri et al., 2020). Third, although efforts were made to reduce cognitive overload through clean design and pacing, some students may still experience difficulty processing new content while navigating game elements, especially if they are unfamiliar with digital tools (Sweller, 1988). Lastly, the findings may not be fully generalizable to all educational contexts. Cultural differences, prior gaming experience, and institutional infrastructure could influence how students interact with gamified learning environments (Ahmadov et al., 2024). Addressing these limitations provides important context for interpreting the results and offers direction for future improvements.

Implication of the Study

The findings of this study carry important implications for both practice and theory. From a practical standpoint, *CC Facts Race* demonstrates strong potential as an interactive learning tool to improve student comprehension of food and beverage cost control concepts, which are traditionally considered challenging and formula-driven. The game's high usability, engaging content, and satisfaction ratings suggest that it can be effectively integrated into hospitality curricula, especially within polytechnic and vocational institutions. These results support ongoing efforts to adopt more learner-centered, gamified approaches in technical and vocational education and training (TVET), where hands-on engagement is critical for success (Hainey et al., 2016).

From a theoretical perspective, this study contributes to gamification research by grounding its design in Self-Determination Theory (Deci & Ryan, 1985), thereby illustrating how game mechanics can be intentionally aligned with psychological needs for autonomy, competence, and relatedness. Furthermore, the study highlights the importance of contextual sensitivity in usability, recognizing that what works well in one learning environment may require adaptation in another (Ahmadov et al., 2024). While the tool shows consistent results across a specific sample, broader implementation should consider institutional readiness, digital infrastructure, and student diversity. Educators are encouraged to view gamification not merely as a novelty but as a pedagogical approach that requires careful alignment with learning objectives, accessibility considerations, and instructional design principles.

Conclusion

This study demonstrates that the *CC Facts Race* educational online game performs strongly in terms of usability, player experience, and student satisfaction, with all mean scores exceeding 4.50 on a 5-point scale. These results indicate that students found the game intuitive, engaging, and effective for learning food and beverage cost control concepts. The game's design, which is characterized by attractive visuals, clear instructions, and appropriate challenge levels, aligns with recent findings that well-structured gamified tools enhance learner motivation and skill acquisition (Subhash & Cudney, 2018; Dahalan et al., 2024). These findings also support Self-Determination Theory (Deci & Ryan, 1985), suggesting that students experienced increased autonomy, competence, and relatedness while engaging with the game. Furthermore, the study's results reinforce that the game successfully avoids common pitfalls such as excessive complexity (Ninaus & Nebel, 2021) and disengagement due to monotonous mechanics (Hainey et al., 2019).

However, while the findings are promising, researchers acknowledge that the study's scope is limited by the lack of a control group and reliance on a single data collection method. Future studies should adopt an experimental or quasi-experimental design to evaluate the causal impact of the game on learning outcomes. Such approaches, which include pre-test and post-test control group designs, are widely recognized for their ability to establish causality in educational research (Campbell & Stanley, 1963; Creswell & Creswell, 2018). Comparing *CC Facts Race* with conventional instructional strategies—such as lecture-based or blended learning methods—would provide a more rigorous assessment of its effectiveness and educational value. Additionally, evaluating the game against other gamification strategies could help isolate which game elements (e.g., competition, feedback, narrative) are most influential in improving motivation, engagement, and knowledge retention (Dichev & Dicheva, 2017). These future directions will not only enhance the generalizability of the findings but also contribute to theory-building in gamified learning design.

Recommendation for Future Research

To build upon the current findings and address their limitations, future research should consider several directions. First, experimental or quasi-experimental designs, which incorporate pre-tests, post-tests, and control groups, are recommended to better evaluate the causal effects of gamified interventions compared to traditional teaching methods (Creswell & Creswell, 2018). This approach would provide more robust evidence of the effectiveness of *CC Facts Race* in improving academic outcomes, such as test performance or skill proficiency.

Second, longitudinal studies could explore the lasting impact of the game on knowledge retention and the transfer of learning to real-world hospitality settings. Tracking students over time would provide insights into whether the observed motivational and cognitive benefits persist beyond initial exposure. Third, researchers are encouraged to include qualitative components, including interviews, reflective journals, or gameplay observations, to gain deeper insights into student behavior, engagement patterns, and emotional responses. Fourth, future studies should also explore instructor perspectives—specifically how they perceive the game's alignment with course learning outcomes and their readiness to facilitate gamified instruction. Finally, it is recommended that future iterations of the game undergo accessibility testing to ensure that all students, particularly those with disabilities or limited digital literacy, can benefit from the platform. These enhancements will help position *CC Facts Race* not only as an effective digital tool but also as a scalable and inclusive model for gamified learning in hospitality and other applied disciplines.

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Author Contribution

NF Mohamad Noor Afandi – Conceptualization, data curation, Writing – original draft; DSE Shahsuzanni – Investigation, formal analysis; NF Faizal – Investigation, formal analysis; K Sommar – Methodology; Z Zulkifli – Methodology; SN Sanusi – Conceptualization, data curation, Writing – original draft; AK Roseline –

Supervision, Validation, Writing – review & editing; WB Quah – Supervision, Validation, Writing – review & editing.

Conflict of Interest

Authors declare no conflict of interest.

Declaration on the Use of Generative AI

The author acknowledges the use of Generative Artificial Intelligence (AI) tools, specifically ChatGPT by OpenAI, for the sole purpose of language enhancement during the manuscript preparation process.

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