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JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

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Welcoming *Remarks*

Assalamualaikum Warahmatullahi Wabarakatuh, and a very warm welcome to the fourth volume of the KIMARA Journal!

As Director of Politeknik Kota Kinabalu, I am immensely proud to witness the continued growth and success of this esteemed publication. KIMARA Journal serves as a vital platform for researchers, academics, and practitioners to share their innovative ideas, research findings, and scholarly insights, contributing significantly to the advancement of knowledge in various fields.

This volume, like its predecessors, showcases a diverse range of high-quality articles that reflect the intellectual vibrancy and research excellence within our academic community and beyond. I extend my heartfelt appreciation to all the authors who have contributed their valuable work to this edition. Your dedication to rigorous research and scholarly writing is the cornerstone of KIMARA Journal's success.

I also wish to express my sincere gratitude to the entire KIMARA Journal team. Your unwavering commitment to excellence, meticulous attention to detail, and tireless efforts in managing the peer-review process, editing, and publication have been instrumental in bringing this volume to fruition. Your passion for promoting scholarly communication is truly commendable.

It is my hope that KIMARA Journal will continue to serve as a catalyst for intellectual discourse, fostering collaboration and innovation among researchers and practitioners. I envision future issues expanding its scope, reaching new audiences, and further solidifying its reputation as a leading academic publication.

I look forward to the continued success of KIMARA Journal and its contribution to the advancement of knowledge and scholarship.

Thank you.



MD. NOR BIN ABDUL HALIM
Director
Politeknik Kota Kinabalu

Welcoming *Remarks*

Assalamualaikum Warahmatullahi Wabarakatuh, and a very good day to everyone.

As the Deputy Director of Academics at Politeknik Kota Kinabalu, it gives me great pleasure to welcome you to the launch of KIMARA Journal Volume 4, 2025. This volume represents a significant milestone in our ongoing commitment to fostering academic excellence and promoting scholarly discourse.

KIMARA Journal has consistently provided a platform for researchers and academics to share their insights and contribute to the body of knowledge across various disciplines. This year, we are particularly proud to present a diverse collection of papers spanning STEM, Education, Sustainability, Religious Studies, and General Studies. This multidisciplinary approach reflects the dynamic and interconnected nature of modern research and its relevance to our society.

I would like to express my sincere appreciation to all the authors who have contributed their valuable research to this volume. We are especially grateful for the contributions from various institutions, both within Malaysia and beyond. Your dedication to rigorous research and scholarly writing is essential to the success of KIMARA Journal. Your willingness to share your expertise enriches our understanding and drives innovation in your respective fields.

The editorial team has worked tirelessly to ensure the quality and integrity of this publication, and I commend them for their dedication and professionalism.

I am confident that KIMARA Journal Volume 4 will serve as a valuable resource for students, researchers, and practitioners alike. I encourage you to delve into the articles presented here, engage with the ideas, and contribute to the ongoing dialogue.

Thank you.

Ts. ABDUL RAZAK BIN MOHD DAIM
Deputy Director of Academics
Politeknik Kota Kinabalu



Foreword

Assalamualaikum and greetings,

It gives me great pleasure to welcome the publication of the Kinabalu Multidisciplinary Academic Research Journal (Vol. 4, 2025), which brings together a collection of research findings, critical perspectives, and innovations from scholars, researchers, and professionals across various disciplines.

This journal serves as an essential platform that strengthens academic collaboration across fields such as science, engineering, technology, education, humanities, and management. The multidisciplinary approach highlighted herein is vital in addressing the complex and evolving global challenges that require knowledge integration, collaboration, and impactful research efforts.

The editorial team and the publisher deeply appreciate the commitment of all authors, reviewers, and editorial members who have contributed their expertise to ensure the quality and integrity of this publication. It is our hope that this journal will serve as a credible reference and catalyst for knowledge creation and innovation both locally and internationally.

In conclusion, may the Kinabalu Multidisciplinary Academic Research Journal continue to stand as a premier platform that unites diverse academic perspectives and strengthens the research ecosystem within Jabatan Pendidikan Politeknik Kolej Komuniti (JPPKK), Politeknik Kota Kinabalu (PKK) and the global scholarly community.

Thank you.

Dr. MOHD ISA BIN JAFFAR
Head of Research, Innovation and Commercialisation Unit
Politeknik Kota Kinabalu, Malaysia



Editorial Note

Assalamualaikum Warahmatullahi Wabarakatuh and Greetings,

As the Publication Coordinator from the Research, Innovation and Commercialization Unit, Politeknik Kota Kinabalu, I am delighted to welcome you to KIMARA Journal Volume 4, 2025. The publication of this journal marks another significant achievement in our ongoing efforts to promote research, innovation, and knowledge sharing in various fields.

KIMARA Journal Volume 4 covers a variety of relevant and important categories, including:

- Sociology and Philosophy in Education
- Education Issues, Theories and Practices
- Lifelong Learning
- General Studies
- Action Research
- Science, Technology, Engineering & Math (STEM)
- Sustainable Development
- Creativity and Innovation
- Islamic and Moral Education

We are very pleased to feature high-quality scholarly contributions from researchers, lecturers, and practitioners from various institutions, including participation from the 3rd International General Studies Conference organized by PolyCC with the theme: Leveraging Innovative Pedagogy in Digital Era. I would like to express my deepest appreciation to all article contributors for your dedication and commitment in producing insightful and innovative works. Your contributions are invaluable in enriching the treasury of knowledge and driving progress in your respective fields. Not to forget, my endless gratitude to the entire KIMARA Journal editorial team for your hard work, dedication, and high professionalism in ensuring that the publication of this journal runs smoothly and successfully. You are all the backbone of this success.

In conclusion, I hope that KIMARA Journal Volume 4 will be a useful reference and inspire readers to continue creating, innovating, and contributing to national development.

Thank you.



Dr. SUZAN BINTI IMPAK
Publication Coordinator
Research, Innovation and Commercialization Unit
Politeknik Kota Kinabalu

Chief Editor's Speech

Assalamualaikum warahmatullahi wabarakatuh and warm greetings to all.

It is my great pleasure to present the Kinabalu Multidisciplinary Academic Research Journal (KIMARA), Volume 4, December 2025. This volume reflects the dedication, creativity, and scholarly excellence of our contributors, whose work continues to inspire and advance knowledge.

My sincere gratitude goes to all authors, reviewers, and the Editorial Board for their commitment to maintaining the quality and integrity of this journal. I also thank the Publication Committee, the Research, Innovation, and Commercialization Unit, and the management of Politeknik Kota Kinabalu for their unwavering support.

I hope this volume will spark curiosity, foster collaboration, and inspire new ideas that contribute meaningfully to our academic community and society.

Thank you.

NORAINI BINTI LUNCHIN
Chief Editor
Kinabalu Multidisciplinary Academic Research Journal (KIMARA),
Volume 4, December 2025



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CATEGORY: EDUCATION

KINABALU MULTIDISCIPLINARY ACADEMIC RESEARCH JOURNAL VOLUME 4, DECEMBER 2025
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POLITEKNIK KOTA KINABALU

PERBANDINGAN PENCAPAIAN PELAJAR DALAM PENGGUNAAN *e-BOOK* INTERAKTIF DCC50212 HYDROLOGY BAGI PELAJAR DIPLOMA KEJURUTERAAN AWAM, POLITEKNIK KOTA KINABALU

Mohamed bin Saim[1*], Kristy Wong[2], Tan Siew Ning[3]

[1,2,3]Jabatan Kejuruteraan Awam, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

*mohamed@polikk.edu.my

Abstrak

Kemajuan teknologi telah banyak mempengaruhi sistem pendidikan negara dengan mengubah paradigma pembelajaran kontemporari. Peningkatan bilangan institusi pendidikan telah memulakan peralihan kepada buku teks digital, di dalam dan luar bilik kuliah. Dalam era digital ini, integrasi teknologi dalam pendidikan telah muncul sebagai keutamaan yang paling utama. e-Buku mewakili satu bentuk teknologi yang secara progresif diasimilasikan ke dalam amalan pedagogi. Kepelbagaian bahan pengajaran dan pembelajaran merangkumi penggunaan pelbagai sumber untuk memperkukuh pembelajaran pelajar, termasuklah teks bercetak, bahan pendengaran, alat bantu visual, dan kandungan interaktif yang boleh diakses melalui teknologi. Objektif menyeluruh adalah untuk memberikan pengalaman pembelajaran yang lebih menarik, berkesan, dan diperbadikan yang sesuai dengan keutamaan pembelajaran pelajar individu. Matlamat utama kajian ini adalah untuk menilai prestasi akademik pelajar Diploma Kejuruteraan Awam Semester 5 untuk Sesi II 2024/2025 yang mendaftar dalam kursus DCC50212 Hidrologi, khususnya menumpulkan pada Hasil Pembelajaran Kursus (*CLO1* dan *CLO2*). Kajian ini melibatkan 2 kohort pelajar: satu menggunakan menggunakan alat bantu pembelajaran e-buku interaktif dan satu lagi hanya bergantung pada bahan tradisional. Politeknik Kota Kinabalu, dengan kerjasama Politeknik Melaka dan Politeknik Mukah telah dilantik sebagai institusi perintis bagi pelaksanaan e-buku interaktif bertajuk "Penyelesaian Masalah: Hidrologi Kejuruteraan," yang dibangunkan secara kolaboratif oleh ketiga-tiga institusi tersebut. Penyelidikan ini merangkumi sampel 38 pelajar, terdiri daripada 24 individu daripada kelas DKA5A (yang terlibat dengan kedua-dua nota kuliah dan e-buku) dan 14 individu daripada kelas DKA5B (yang menggunakan nota kuliah secara eksklusif). Metodologi analisis kuantitatif telah digunakan, dengan markah Penilaian Berterusan (PB) daripada Kuiz (*CLO1*) dan Ujian (*CLO2*) tertakluk kepada analisis statistik inferensi. Ujian-T Sampel Tak Bersandar atau Ujian-t dan Ujian *Levene* telah dilaksanakan menggunakan Pakej Statistik untuk Sains Sosial (SPSS) dan *Microsoft Excel*. Hasil dapatan kajian ini telah menunjukkan bahawa terdapat perbezaan min yang signifikan dalam skor PB Kuiz dan Ujian bagi kedua-dua pencapaian Hasil Pembelajaran Kursus *CLO1* dan *CLO2* dalam kalangan pelajar yang menggunakan e-buku interaktif. Bagi *CLO1*, skor min bagi kelas DKA5A (nota kuliah dan e-buku) ialah 68.5417, berbeza dengan 47.2857 kelas DKA5B (nota kuliah sahaja). Bagi *CLO2*, skor min untuk kelas DKA5A ialah 63.8333 berbanding 29.4714 untuk kelas DKA5B. Ini jelas menunjukkan bahawa pelajar yang menggunakan e-buku interaktif mencapai skor PB lebih tinggi berbanding pelajar yang menggunakan buku secara fizikal (nota kuliah) sahaja. Maka, dapatlah disimpulkan bahawa penggabungan e-buku interaktif sebagai alat bantu pembelajaran secara signifikan meningkatkan kefahaman, prestasi akademik dan motivasi pelajar.

***Kata kunci**: E-buku, alat bantu pembelajaran interaktif, Hidrologi, Statistik Inferensi, Ujian-T Tak Bersandar.*

1. Pengenalan

Perubahan teknologi turut sama mempengaruhi sistem pendidikan negara dengan merubah corak pembelajaran pelajar-pelajar pada masa kini. Kebanyakan institusi pendidikan telah mula beralih kepada penggunaan buku secara digital sama ada dalam dan luar bilik kuliah (Abdul Aziz, S. N. F. et. al., 2025). Dalam era digital ini, integrasi teknologi dalam pendidikan telah muncul sebagai keutamaan yang paling utama. e-Buku mewakili satu bentuk teknologi yang secara progresif diasimilasikan ke dalam amalan pedagogi. Kepelbagaian bahan pengajaran dan pembelajaran merangkumi penggunaan pelbagai sumber untuk memperkukuh pembelajaran pelajar, termasuk teks bercetak, bahan pendengaran, alat bantu visual, dan

kandungan interaktif yang boleh diakses melalui teknologi. Objektif menyeluruh adalah untuk memberikan pengalaman pembelajaran yang lebih menarik, berkesan, dan diperibadian yang sesuai dengan keutamaan pembelajaran pelajar individu.

e-Buku bercirikan interaktif semakin meluas digunakan dalam institusi pendidikan tinggi termasuklah Politeknik Malaysia sebagai bahan pembelajaran berasaskan teknologi. Politeknik Kota Kinabalu, dengan kerjasama Politeknik Melaka dan Politeknik Mukah telah dilantik sebagai institusi perintis bagi pelaksanaan e-buku interaktif yang dibangunkan secara kolaboratif oleh ketiga-tiga institusi tersebut dan telah berjaya diterbitkan pada tahun 2024 bertajuk "Penyelesaian Masalah: Hidrologi Kejuruteraan" untuk pelajar Diploma Kejuruteraan Awam Semester 5.

Berdasarkan kepada dapatan kajian yang telah dijalankan oleh Abdul Aziz, S. N. F. et. al. (2025), mendapati bahawa maklum balas yang diberikan oleh pelajar-pelajar menunjukkan bahawa mereka memberikan respon yang sangat positif mengenai penggunaan e-buku interaktif "Penyelesaian Masalah: Hidrologi Kejuruteraan" yang diterbitkan ini dalam proses pembelajaran. Responden mendapati bahawa ciri-ciri e-buku yang menarik dan bersifat interaktif mampu meningkatkan pemahaman pelajar dalam pembelajaran.

Walau bagaimanapun, pada pendapat Tengku Ibrahim, T. D. et. al. (2024, November) masih terdapat kekurangan data kuantitatif mengenai kesesuaian buku elektronik untuk pelajar politeknik. Maka, kajian sistematik perlu dijalankan untuk menilai sejauh mana penggunaan alat bantu pembelajaran e-buku interaktif ini dapat membantu meningkatkan pencapaian pelajar. Tanpa maklumat empirikal, sukar untuk menentukan sama ada pendekatan ini benar-benar berkesan atau perlu ditambah baik. Oleh itu, satu kajian perbandingan pencapaian pelajar diperlukan bagi menilai tahap keberkesanan penggunaan e-buku dalam aktiviti pengajaran dan pembelajaran.

Justeru, matlamat utama kajian ini adalah bertujuan untuk menilai prestasi akademik pelajar Diploma Kejuruteraan Awam Semester 5 untuk Sesi II 2024/2025 yang mendaftar dalam kursus DCC50212 Hidrologi khususnya menumpukan pada Hasil Pembelajaran Kursus atau *Course Learning Outcome* (*CLO1* dan *CLO2*). Kajian ini melibatkan 2 kohort pelajar: satu menggunakan alat bantu pembelajaran e-buku interaktif dan satu lagi hanya bergantung pada bahan tradisional. Jadual 1 menunjukkan Hasil Pembelajaran Kursus (*Course Learning Outcome* - *CLO*) DCC50212 Hydrologi. Kajian ini hanya melibatkan pencapaian markah Penilaian Berterusan (PB) (*Contiuous Assessment* - *CA*) bagi *CLO1* dan *CLO2*. *CLO1* melibatkan markah PB Kuiz yang merangkumi Topik 1 - Topik 3 dan manakala *CLO2* melibatkan markah PB Ujian yang merangkumi Topik 4 - Topik 5.

1.1 Objektif Kajian

Objektif kajian ini adalah seperti berikut:

i. Mengenal pasti sama ada terdapat perbezaan yang signifikan dalam pencapaian *CLO1* **(Kuiz: Topik 1 - 3)** kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

ii. Mengenal pasti sama ada terdapat perbezaan yang signifikan dalam pencapaian *CLO2* **(Ujian: Topik 4 - 5)** kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

1.2 Persoalan Kajian

Persoalan kajian ini adalah seperti berikut:

i. Adakah terdapat perbezaan yang signifikan dalam pencapaian *CLO1* **(Kuiz: Topik 1 - 3)** kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja)?

ii. Adakah terdapat perbezaan yang signifikan dalam pencapaian *CLO2* **(Ujian: Topik 4 - 5)** kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja)?

1.3 Skop Kajian

Kajian ini melibatkan seramai 38 orang sampel pelajar Semester 5 bagi Sesi II 2024/2025 yang mengambil dan mendaftar dalam kursus DCC50212 Hidrologi iaitu 24 orang pelajar dari kelas DKA5A (nota kuliah dan e-buku) dan 14 orang pelajar dari kelas DKA5B (nota kuliah sahaja).

1.4 Hipotesis Kajian

Hipotesis 1:

H_O: Tidak terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Kuiz untuk pencapaian CLO1 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

H_I: Terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Kuiz untuk pencapaian CLO1 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

Syarat:
Tolak H_O jika nilai-$p < \alpha = 0.05$

Hipotesis 2:

H_O: Tidak terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Ujian untuk pencapaian CLO2 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

H_I: Terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Ujian untuk pencapaian CLO2 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

Syarat:
Tolak H_O jika nilai-$p < \alpha = 0.05$

Jadual 1. Hasil Pembelajaran Kursus DCC50212 Hidrologi.

COURSE INFORMATION	
POLITEKNIK MALAYSIA	DEPARTMENT OF POLYTECHNIC AND COMMUNITY COLLEGE EDUCATION, MINISTRY OF HIGHER EDUCATION
7	**COURSE LEARNING OUTCOMES (CLO):** Upon completion of this course, students should be able to: CLO1 : apply basic concept of applied hydrology in civil engineering (C3 , PLO 1) CLO2 : solve problem in applied hydrology for civil engineering (C4 , PLO 2) CLO3 : construct hydrological analysis using available software (P3 , PLO 7)

2. Kajian Literatur

Dunia digital kini telah banyak memberi kesan kepada kaedah dalam proses mendapatkan maklumat. Kecenderungan dalam mencari dan mendapatkan maklumat yang lebih pantas dengan menggunakan teknologi sedia ada tanpa batasan secara dalam talian adalah lebih tinggi berbanding dengan kaedah secara tradisional menggunakan bahan bercetak seperti buku. Penggunaan teknologi dengan cara yang bijak dan berkesan dapat membantu meningkatkan pengalaman pembelajaran dan membolehkan seseorang pelajar mengembangkan kemahiran baharu dengan lebih efektif (Parker, C. et. al., 2019). Dengan kemudahan teknologi maklumat dan komunikasi serta elemen multimedia, e-pembelajaran dapat mengatasi banyak masalah kaedah pengajaran tradisional dan membantu meningkatkan pemahaman pelajar dari pelbagai aspek pembelajaran (Jamaludin, R., 2005). Menurut Dumbiri, D. N., & Nwadiani, C. O. (2020), di dalam e-pembelajaran kebanyakan sumber yang disediakan adalah secara digital dan boleh wujud dalam pelbagai bentuk seperti video, podcast, slaid, e-nota, *e-book* dan pelbagai lembaran kerja digital. *e-Book* merupakan salah satu bahan pendidikan digital yang semakin giat dihasilkan pada masa kini.

Buku digital atau *e-book* bukanlah sesuatu yang baru digunakan di dunia. Penggunaan buku digital mula digunakan bermula pada tahun 70-an dengan Projek Guttenberg iaitu suatu domain perpustakaan secara digital (Alsalhi, N. R. et. al., 2020). *e-Book* merujuk kepada buku digital yang boleh diakses melalui peranti elektronik seperti komputer, *tablet* dan *smartphone*. *e-Book* menawarkan pelbagai kelebihan seperti kemudahan aksesibiliti (Koloseni, D. N. et. al., 2021). Gardiner, E., & Musto, R. G. (2015), mendefinisikan *e-book* sebagai buku dalam bentuk digital yang terdiri daripada teks dan imej boleh dibaca pada komputer atau peranti elektronik lain. *e-Book* meliputi komponen asas sama seperti buku bercetak iaitu teks, gambar, graf dan jadual. Walau bagaimanapun, *e-book* diberi nilai tambah dengan komponen lain seperti audio, visual, animasi, dan *hyperlink* untuk penyampaian maklumat yang lebih bermakna berbanding buku

tradisional (Suriyani, N., 2016). Penggunaan e-book oleh pelajar telah mengubah cara pengajaran, cara pembelajaran lebih terbuka, dan pelajar boleh mengakses semua jenis maklumat dengan cepat (Ahmad, N. et. al., 2022).

Menurut Alfiras, M., & Bojiah, J. (2020), kebanyakan pelajar gemar menggunakan *e-book* kerana ianya mudah didapati dengan hanya menggunakan telefon bimbit, tidak memerlukan ruang untuk simpanan secara fizikal dan boleh didapati dengan harga yang berpatutan. Kajian mereka juga mendapati kebanyakan pelajar berminat dalam menggunakan *e-book* kerana ianya mempunyai banyak kelebihan praktikal dan ekonomi yang membuatnya menjadi pilihan yang popular dalam kalangan pelajar. Ia memudahkan akses kepada bahan pembelajaran dengan cara yang lebih mudah, fleksibel, dan ekonomi. Penyataan ini turut disokong oleh Casselden, B., & Pears, R. (2020), pelajar memilih untuk menggunakan *e-book* berbanding buku fizikal kerana sifat mudah alihnya di mana mereka boleh membuat capaian secara berulang-ulang kepada *e-book* yang hendak digunakan melalui peranti elektronik masing-masing tanpa perlu merasa terbeban. Pelajar yang menggunakan *e-book* secara konsisten menunjukkan peningkatan dalam pemahaman konsep berbanding mereka yang menggunakan bahan cetak (Alvarez, J., 2019). Ahmad, N., & Razak, L. (2024) berpendapat bahawa ini menunjukkan *e-book* memiliki banyak kelebihan berbanding buku fizikal sejajar dengan perkembangan teknologi digital pada masa kini.

Kajian Wang, S. (2015) mendapati pelajar yang menggunakan buku elektronik menunjukkan peningkatan dalam pemahaman dan ingatan. Dapatan kajian ini menguatkan lagi penyataan oleh Sami M. Alshehri (2021) bahawa penggunaan teknologi pembelajaran seperti *e-book* mampu meningkatkan prestasi pelajar. Pelajar amat terdorong untuk meningkatkan prestasi mereka apabila kolaboratif dan persekitaran pembelajaran interaktif telah dicipta dengan kemasukan *e-book*. Rosida et. al., (2017) dalam kajiannya di mana penggunaan *e-book* secara interaktif sangat berkesan untuk memupuk kemahiran berfikir pelajar dengan lebih kritis dan kreatif. Dapatan ini turut disokong oleh Hermansyah, H. et. al., (2017) dan Harjono, A. et. al., (2020) bahawa pengisian di dalam *e-book* yang bersifat interaktif mempunyai potensi besar untuk membantu meningkatkan kemahiran berfikir secara kreatif dalam kalangan pelajar. Kandungan *e-book* yang menarik dan interaktif membolehkan mereka memperoleh maklumat dengan lebih cepat dan berkesan. *e-Book* yang bersifat interaktif juga dikaitkan dengan meningkatkan daya ingatan dan kefahaman pelajar (Rosly, M. R., 2024, March). Abdul Aziz, N. et. al., (2023) turut bersetuju bahawa dengan penggunaan *e-book* interaktif membolehkan pelajar untuk belajar mengikut kadar pembelajaran masing-masing. Hal ini dapat meningkatkan pemahaman mereka tanpa mengganggu kelajuan pembelajaran pelajar-pelajar lain.

Kajian keberkesanan penggunaan *e-Book* dalam pendidikan telah menjadi topik yang semakin popular dalam beberapa tahun terakhir. Carian melalui *google scholar* dengan kata kunci *e-Book effectiveness* memberikan sebanyak 106,000 kertas penyelidikan yang berkaitan (Abdullah, A. Z. et. al., 2023, October). Menurut Sami M. Alshehri (2021), kajian mengenai keberkesanan penggunaan *e-book* ini adalah penting untuk mendorong perubahan dalam gaya pembelajaran dan kaedah tradisional yang diguna pakai oleh penyedia pendidikan untuk meningkatkan keupayaan pembelajaran kognitif bagi para pelajar. Secara keseluruhan, dapatan daripada literatur yang lalu menunjukkan bahawa e-buku mempunyai potensi besar dalam menyokong aktiviti pengajaran dan pembelajaran pelajar. Oleh itu, kajian perbandingan pencapaian pelajar dalam penggunaan e-buku interaktif adalah penting dan bertujuan untuk menilai sejauh mana e-buku interaktif dapat membantu dalam pencapaian pelajar bagi kursus DCC50212 Hidrologi. Hasil kajian ini diharapkan dapat membantu pengkaji memperbaiki

kaedah pengajaran dan pembelajaran dalam usaha meningkatkan pencapaian dan memastikan pemahaman yang lebih baik dalam kalangan pelajar.

3. Metodologi Kajian

e-Buku ini dibangunkan menggunakan perisian *Canva* templat reka bentuk grafik dan kemudiannya nota pengajaran ditukar ke dalam format *PDF* menjadi e-buku. Di dalam e-buku tersebut telah dimuatnaik dengan penggunaan pautan *QR code* dalam usaha mewujudkan pembelajaran yang lebih menarik dan e-buku lebih bersifat interaktif. *e-Book* yang mempunyai ciri-ciri interaktif dapat memperkaya pengalaman dalam pembelajaran dan memberikan peluang untuk lebih mendalam dalam memahami konsep-konsep serta menggalakkan minat dan keseronokan dalam proses pembelajaran (Sung H. Y. et. al., 2019). Melalui imbasan *QR code* tersebut, pelajar boleh mengakses video penerangan tentang topik berkaitan yang dipelajari dan pelajar juga diminta untuk memberikan maklum balas di akhir setiap topik pembelajaran.

Populasi boleh ditakrifkan sebagai satu ciri yang menunjukkan cerapan atau ukuran tertentu ke atas sekumpulan individu atau objek. Ahli populasi mestilah mempunyai salah satu ciri atau sifat yang boleh dicerap dan diukur antara satu sama lain (Konting, M. M., 2004). Kaedah persampelan bertujuan (*purposive*) atau sampel menyeluruh/populasi kecil telah dipilih oleh pengkaji dalam melaksanakan kajian ini. Sehubungan itu, kajian yang dijalankan ini merangkumi sampel 38 orang pelajar (n=38) Semester 5 Diploma Kejuruteraan Awam untuk Sesi II 2024/2025 yang mendaftar dalam kursus DCC50212 Hidrologi. Seramai 24 individu daripada kelas DKA5A (yang terlibat dengan kedua-dua nota kuliah dan e-buku) dan 14 individu daripada kelas DKA5B (yang menggunakan nota kuliah secara eksklusif). Kedua-dua kelas berkenaan, kursus diajar oleh pensyarah yang berlainan. Taburan normal biasanya berlaku apabila saiz sampel sama atau lebih besar daripada 50 (Chua Yan Piaw, 2006). Menurut Julie Pallant (2011), saiz sampel 30 dan ke atas adalah memadai untuk memenuhi syarat kenormalan. Norma bilangan pelajar setiap kelas bagi sesi pengajian Sesi II ialah bilangan minima 16 orang pelajar. Namun, keterbatasan perbezaan bilangan pelajar antara kelas DKA5A dan DKA5B ini adalah disebabkan oleh konflik Jadual Waktu Perkuliahan kepada pelajar semester akhir yang Mengulang Kursus bagi kursus-kursus tertentu yang saling bertembung.

Kajian ini menggunakan kaedah analisis kuantitatif. markah Penilaian Berterusan (PB) khusus untuk topik yang berkaitan dengan Hasil Pembelajaran Kursus atau *Course Learning Outcome* (*CLO1* dan *CLO2*) di mana *CLO1* melibatkan markah PB Kuiz yang merangkumi Topik 1 - Topik 3 dan manakala *CLO2* melibatkan markah PB Ujian yang merangkumi Topik 4 - Topik 5 bagi sesi tersebut. Data PB (rujuk Jadual 2) diekstrak menggunakan *Microsoft Excel* sebelum dianalisis dengan Pakej Statistik untuk Sains Sosial (SPSS). Seterusnya, Ujian-T Sampel Tak Bersandar atau Ujian-t dan Ujian *Levene* dianalisis. Ujian *Levene* dijalankan terlebih dahulu bagi melihat kehomogenan (kesamaan) variansi adalah dipenuhi sebelum Ujian-t dijalankan.

Sekiranya nilai-$p < \alpha = 0.05$, maka Hipotesis nol (H_o) akan ditolak dan menunjukkan bahawa terdapat perbezaan min skor yang signifikan. Berikut merupakan penyataan hipotesis yang digunakan untuk kedua-dua ujian tersebut.

Ujian Levene:

H_O: Variansi markah homogen/sama bagi kedua-dua kumpulan DKA5A dan DKA5B.
H_I: Variansi markah tidak homogen/sama bagi kedua-dua kumpulan DKA5A dan DKA5B.

Syarat:
Jika nilai-*p* bagi *Levene's Test* > 0.05 bermaksud variansi diandaikan sama bagi kumpulan DKA5A dan DKA5B. Maka kita perlu rujuk nilai-*p* (*Sig.(2-tailed*) pada baris/*row* atas.
Sebaliknya, jika nilai-*p* bagi *Levene's Test* < 0.05 bermaksud variansi diandaikan tidak sama bagi kumpulan DKA5A dan DKA5B. Maka kita perlu rujuk nilai-*p* (*Sig. (2-tailed*) pada baris/*row* bawah.

Ujian-t:

Hipotesis 1:

H_O: Tidak terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Kuiz untuk pencapaian CLO1 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kumpulan pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

H_I: Terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Kuiz untuk pencapaian CLO1 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kumpulan pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

Syarat:
Tolak H_O jika nilai-*p* < $\alpha = 0.05$

Hipotesis 2:

H_O: Tidak terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Ujian untuk pencapaian CLO2 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kumpulan pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

H_I: Terdapat perbezaan min skor yang signifikan dalam markah Penilaian Berterusan (PB) Ujian untuk pencapaian CLO2 kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kumpulan pelajar kelas DKA5A (nota kuliah dan e-buku) dan DKA5B (nota kuliah sahaja).

Syarat:
Tolak H_O jika nilai-*p* < $\alpha = 0.05$

Jadual 2. Skor Markah Penilaian Berterusan (PB) Kursus DCC50212 *Hydrology* bagi Sesi II 2024/2025.

Kelas	No.	Sesi II 2425			
		DKA5A	DKA5B	DKA5A	DKA5B
Hasil Pembelajaran Kursus (CLO)		CLO01C		CLO02C	
Wajaran		10%		15%	
Tugasan Penilaian		Skor Kuiz		Skor Ujian	

1	6.5	3	8.2	0.6
2	6.2	2.8	11.7	0.9
3	10	5.5	11.2	0.8
4	7.5	3	10.9	1.5
5	9.2	4.8	11.6	12.6
6	4.8	6.5	8.2	8.7
7	5	4.5	4.1	1.3
8	4	6.5	4.5	11.7
9	9.2	7.8	11.4	9.3
10	4	4.5	6.9	10.3
11	4.5	3.5	2.7	0.9
12	8.2	6.5	9.4	0.8
13	7	3.5	8.5	1
14	6.8	4	9.8	1.5
15	5.5		9.6	
16	6.2		9.2	
17	8		14.7	
18	6.5		9.9	
19	8.2		10.2	
20	7.8		8.8	
21	7.5		9.8	
22	9		14.1	
23	5.5		12.8	
24	7.2		11.6	

4. Analisa dan Perbincangan

Jadual 3 di bawah menunjukkan keputusan analisis Ujian *Levene* dan Ujian-t. Hasil dapatan kajian analisis Ujian *Levene* mendapati bahawa bagi markah Penilaian Berterusan (PB) Kuiz untuk pencapaian *CLO1* nilai-*p* ialah 0.748 ($> \alpha = 0.05$) menandakan variansi markah diandaikan homogen/sama bagi kedua-dua kumpulan DKA5A dan DKA5B. Oleh itu, keputusan Ujian-t perlu rujuk nilai-*p* (*Sig.(2-tailed*) pada baris/*row* atas. Oleh itu nilai-*p* yang dikaji ialah 0.001. Manakala bagi markah Penilaian Berterusan (PB) Ujian untuk pencapaian *CLO2* nilai-*p* ialah 0.001 ($< \alpha = 0.05$) menandakan variansi markah diandaikan tidak homogen/sama bagi kedua-dua kumpulan DKA5A dan DKA5B. Maka kita perlu rujuk nilai-*p* (*Sig.(2-tailed*) pada baris/*row* bawah. Oleh itu nilai-*p* yang dikaji ialah 0.002.

Hasil analisis Ujian-t pula mendapati bahawa bagi **Hipotesis 1**: Markah Penilaian Berterusan (PB) Kuiz untuk pencapaian *CLO1*, oleh kerana nilai-*p* yang dikaji iaitu $0.001 < \alpha$

= 0.05, maka Hipotesis nol (H_O) ditolak. Dengan ini, secara statistiknya bahawa terdapat perbezaan min skor yang signifikan dalam PB Kuiz untuk pencapaian *CLO1* kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (Nilai Min = 68.5417, Sisihan Piawai = 17.11401) dan DKA5B (Nilai Min = 47.2857, Sisihan Piawai = 15.83778), t(36) = 3.793, *P* = 0.001.

Keputusan ini menunjukkan bahawa penggunaan e-buku interaktif memberi kesan positif terhadap pencapaian pelajar bagi *CLO1*. Pelajar yang menggunakan e-buku dilihat lebih memahami konsep asas topik awal (Topik 1 - Topik 3) berbanding pelajar yang hanya menggunakan nota kuliah sahaja. Penemuan ini selari dengan dapatan Sung H. Y. et. al. (2019) yang melaporkan e-buku interaktif mampu meningkatkan minat dan kefahaman pelajar kerana adanya elemen multimedia seperti video dan pautan *QR code* yang menambahbaik pengalaman pembelajaran.

Manakala bagi **Hipotesis 2**: Markah Penilaian Berterusan (PB) Ujian untuk pencapaian *CLO2*, oleh kerana nilai-*p* yang dikaji iaitu 0.002 < α = 0.05, maka Hipotesis nol (H_O) ditolak. Dengan ini, secara statistiknya bahawa terdapat perbezaan min skor yang signifikan dalam PB Ujian untuk pencapaian *CLO2* kursus DCC50212 Hidrologi Semester 5 bagi Sesi II 2024/2025 antara kohort pelajar kelas DKA5A (Nilai Min = 63.8333, Sisihan Piawai = 19.34732) dan DKA5B (Nilai Min = 29.4714, Sisihan Piawai = 32.12185), t(18.613) = 3.636, *P* = 0.002.

Ini memberikan petunjuk bahawa pelajar yang menggunakan e-buku memperoleh pencapaian yang lebih baik bagi *CLO2*. Dapatan ini mengesahkan bahawa penggunaan e-buku interaktif turut membantu pencapaian pelajar dalam topik yang lebih kompleks (Topik 4 - Topik 5). Skor yang lebih tinggi bagi kohort e-buku menunjukkan bahan interaktif membantu pelajar menguasai kefahaman aplikasi dan penyelesaian masalah yang lebih mencabar. Hal ini menyokong kajian oleh Abdul Aziz S. N. F. et. al. (2025) yang mendapati e-buku interaktif memberi respon positif daripada pelajar Politeknik kerana ciri-cirinya yang mesra pengguna, interaktif, dan mudah diakses di luar kelas.

Secara keseluruhan, dapatan kajian menunjukkan bahawa pelajar yang menggunakan e-buku interaktif memperoleh pencapaian yang lebih baik dalam kedua-dua *CLO* yang dikaji berbanding pelajar yang hanya bergantung pada nota kuliah. Ini memberi indikasi bahawa penggunaan e-buku interaktif bukan sahaja berkesan dalam meningkatkan pemahaman asas, malah juga membantu pelajar dalam menguasai topik yang lebih mendalam dan kompleks.

Dari sudut pedagogi, penggunaan e-buku interaktif dapat dianggap sebagai satu pendekatan pembelajaran berasaskan teknologi yang relevan dengan gaya pembelajaran generasi pelajar kini. Keupayaan untuk menggabungkan teks, grafik, video, dan pautan interaktif memberi peluang kepada pelajar untuk belajar secara kendiri, fleksibel, dan berulang kali, sesuai dengan teori pembelajaran konstruktivis yang menekankan pengalaman belajar aktif.

Implikasi terhadap pensyarah pula adalah keperluan untuk mula mengintegrasikan teknologi digital seperti e-buku dalam proses pengajaran agar pembelajaran lebih menarik, responsif, dan menepati keperluan semasa.

Jadual 3. Ujian-t Sampel Tak Bersandar.

Group Statistics

	sesi	N	Mean	Std. Deviation	Std. Error Mean
CLO1	Sesi II 2425 5A	24	68.5417	17.11401	3.49338
	Sesi II 2425 5B	14	47.2857	15.83778	4.23282
CLO2	Sesi II 2425 5A	24	63.8333	19.34732	3.94926
	Sesi II 2425 5B	14	29.4714	32.12185	8.58492

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CLO1	Equal variances assumed	.105	.748	3.793	36	.001	21.25595	5.60419	9.89013	32.62177
	Equal variances not assumed			3.873	29.108	.001	21.25595	5.48822	10.03309	32.47881
CLO2	Equal variances assumed	13.261	.001	4.131	36	.000	34.36190	8.31779	17.49264	51.23117
	Equal variances not assumed			3.636	18.613	.002	34.36190	9.44974	14.55552	54.16829

5. Kesimpulan

Berdasarkan analisa dan perbincangan, maka dapat disimpulkan bahawa kohort pelajar kelas DKA5A yang menggunakan e-buku interaktif memperoleh skor markah Penilaian Berterusan (PB) Kuiz untuk pencapaian CLO1 adalah lebih tinggi (Nilai Min = 68.5417, Sisihan Piawai = 17.11401) berbanding kohort pelajar kelas DKA5B yang tidak menggunakan e-buku interaktif (Nilai Min = 47.2857, Sisihan Piawai = 15.83778).

Begitu juga dengan skor markah Penilaian Berterusan (PB) Ujian untuk pencapaian CLO2, kohort pelajar kelas DKA5A yang menggunakan e-buku interaktif memperoleh skor yang lebih tinggi (Nilai Min = 63.8333, Sisihan Piawai = 19.34732) berbanding kohort pelajar kelas DKA5B yang tidak menggunakan e-buku interaktif (Nilai Min = 29.4714, Sisihan Piawai = 32.12185).

Daripada dapatan kajian ini adalah jelas membuktikan bahawa penggunaan e-buku interaktif sebagai alat bantu pembelajaran interaktif ini dapat membantu pelajar meningkatkan pemahaman, pencapaian prestasi dan motivasi mereka. Penggunaan e-buku "Penyelesaian Masalah: Hidrologi Kejuruteraan" untuk kursus DCC50212 Hidrologi dilihat sebagai satu alternatif yang lebih fleksibel dan mudah terutamanya untuk pembelajaran kendiri pelajar.

Penghasilan e-buku ini adalah antara usaha pendidik dan pengkaji untuk meningkatkan pencapaian dan memastikan pemahaman yang lebih baik dalam kalangan pelajar. Beberapa cadangan penambahbaikan kepada pembangunan e-buku ini perlu dilakukan antaranya dengan memperbanyakkan elemen multimedia, latihan simulasi dan permainan pendidikan dalam kandungannya agar lebih menarik. Kajian ini diharapkan dapat memberi sumbangan dan panduan kepada penyelidik atau tenaga pengajar yang berminat untuk menjalankan penyelidikan berkaitan e-buku.

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POLITEKNIK KOTA KINABALU

Factors Influencing the Adoption of Educational AI Tools Among Final Year Students at Polytechnic Kota Kinabalu

Suraya Binti Abd. Warif[1], Mardinah Binti Haris[2], Anbukkarasu Paramasivam[3*]

[1,2,3]Department of Commerce, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

*anbukkarasu@polikk.edu.my

Abstract

The rapid integration of artificial intelligence (AI) tools in educational environments has transformed the teaching and learning process. However, the factors influencing their adoption among higher education students remain limited, particularly in the context of TVET institutions. This study addresses this gap by investigating the determinants of educational AI tool adoption among final year students at Polytechnic Kota Kinabalu. While previous studies have examined technology acceptance broadly, limited attention has been given to the combined effect of perceived ease of use, perceived usefulness, subjective norms, technical competency, and technical simplicity on AI adoption in polytechnic settings. A study using a quantitative correlational design, collected data from 213 students engaged in industrial training using questionnaires adapted from various related studies based on an extended Technology Acceptance Model (TAM). Descriptive findings showed that the most used tools were ChatGPT, Canva and Quill Bot. The primary purpose of using AI-driven educational tools was for writing assistance, grammar checking, translating and note taking. Among the factors examined tech simplicity emerged as the strongest predictor of AI tool adoption, followed by perceived usefulness, subjective norms, and tech competency. Nevertheless, perceived ease of use did not show a significant effect. The model demonstrates strong explanatory power (R2 = 0.687) and substantial predictive relevance (Q2 = 0.541). The finding highlights the importance of simplifying educational tools and emphasising their practical advantages to foster a broader acceptance among TVET institutions' students' learning environment. The study also presents practical implications for lecturers, higher education institutions, AI developers and the Ministry of Higher Education (MOHE) Malaysia seeking to incorporate AI tools into learning settings, highlighting the importance of functionality, usability, and peer influence in facilitating effective AI adoption among students.

Keywords: *Technology Acceptance Model (TAM), Educational AI tools, Polytechnic Kota Kinabalu, and TVET*

1.0 Introduction

The existence and integration of Artificial Intelligence (AI) into an educational setting brings a dramatic change in teaching and learning methods. Moreover, the COVID-19 post-pandemic era has accelerated a global transformation in the higher education sector, driven by the rapid development of new technologies and tools in the teaching and learning process. These changes require strong adaptability and resilience within an educational environment, fundamentally reshaping teaching and learning methods and underscoring the crucial role of technologies (Sharma et al., 2023; Bancoro, 2024). AI tools are increasingly used to provide learners with customised learning assistance, instant feedback and automated answer tasks, thereby increasing engagement and learning effectiveness (Han et al., 2025; Hu, 2024; Osman, 2025; Boubker, 2023). As AI becomes more sophisticated and accessible, many educational institutions are starting to explore and invest in Artificial Intelligence tools to transform traditional pedagogical practices (Bayaga, 2024). However, for AI to be successfully adopted in higher education curriculum, it's essential to understand the factors that influence student adoption (Simsek et al., 2025; Aldraiweesh & Alturki, 2025; Abdulwahab et al., 2024).

Despite the increasing use of Artificial Intelligence tools in education settings, a significant gap persists in understanding the key factors influencing the adoption of these AI tools within Technical and Vocational Education and Training (TVET) institutions such as Polytechnic

Kota Kinabalu. Most previous research focuses on the use and perception of AI among university students in various regions (Swidan et al., 2025; Sergeeva et al., 2025). They overlook the unique pedagogical environments and diverse student demographics of TVET institutions. Because the learning environment at Polytechnic often emphasises practical skills and technical training, the factors influencing technology adoption in this setting may differ from those in traditional learning environments. Furthermore, regional factors in Sabah could introduce unique cultural, infrastructural, and socio-economic considerations that affect how students perceive and adopt new technologies.

There remains a clear study gap in understanding the factors influencing students' adoption of AI tools in higher education, particularly how perceived usefulness, perceived ease of use, subject norms, technology competency and technology simplicity impact their intention to use these tools (Polyportis & Paphos, 2025; Chanda et al., 2025; Foroughi et al., 2025; Rahman, Ismail, et al.,2025). While previous studies overlooked the broader cognitive, behavioural and contextual dynamics that shape students' usage, they have focused on functional benefits and educational consequences of AI chatbots (Akpan et al., 2025; Casheekar et al., 2024; Boubker, 2024; Lin & Yu, 2025). There is limited empirical evidence regarding the incorporation of the core constructs of the Technology Acceptance Model (TAM), including perceived usefulness, perceived ease of use, subjective norms, technology competency, and technology simplicity, in the context of AI educational tools adoption for enhancing learning effectiveness in TVET institutions like Polytechnics.

To bridge this gap, this study will explore the factors that influence final year students at Polytechnic Kota Kinabalu to adopt AI tools. Understanding adoption dynamics among final year students at Polytechnic Kota Kinabalu is crucial because they are at a pivotal stage of their academic journey, preparing for their careers, where their digital skills and AI acceptance readiness are essential for sustaining them in the current digital era workplace environment. Understanding their adoption factors will help taillor strategies and policies for better AI integration in Technical and Vocational Education and Training (TVET) settings. Few previous studies show that students in Malaysian higher education generally have positive views of AI tools (Khairuddin et al., 2024; Rahman et al., 2025), reinforcing the need for deeper investigation in this environment.

Therefore, this study sets out to a) identify the most frequently utilized AI tools in education, b) explore the primary purpose for using AI tools, c) examine the impact of perceived ease of use, perceived usefulness, subjective norms, tech competency and tech simplicity on the adoption of educational AI tools and d) determine which factor the most significantly impacts students' decisions to adopt educational AI tools.

By applying an extended TAM framework to a TVET environment, this study aims to provide a comprehensive understanding and practical recommendations for optimising AI integration to enhance students' learning experiences and prepare them for a technologically advanced future in a rapidly evolving digital world.

2.0 Theoretical Underpinning and Conceptual Framework

Study applied the Technology Acceptance Model (TAM), initiated by Fred Davis in 1989 (Davis et al., 1989). This model proposed that user's decision to adopt a technology are mainly influence by two core believes. The first variable is Perceived Ease of Use (PEoU), defined as

a person's or organization's belief in a system that can facilitate their work. PEoU greatly affects consumers' attitudes and behavioral intentions regarding the adoption of new technology (Abulail et al., 2025b). The second variable is Perceived Usefulness (PU), defined as the extent to which a person believes that using a particular technology will enhance her/his job performance (Davis et al., 1989). Previous studies have shown that Perceived Usefulness has a direct impact on the intention to adopt a technology, while Perceived Ease of Use influences adoption intentions indirectly by strengthening perceptions of usefulness (Lavidas et al., 2019; Hellali et al., 2023).

To gain deeper understanding of student's behaviour regarding adoption of educational AI tools. This study extends the original TAM by integrating three more additional variables relevant to this context. Subjective Norma, Tech Competency and Tech simplicity. Each of these additional variables has meaning in terms of social pressuring influencing technology use, users' digital proficiency and how straightforward the AI tools is to interact with users (Mustofa et al., 2025; Rahman et al., 2025; Rahman Ismail et al., 2025). These additional variables reflect realities of the educational setting, where integration of social influences, users' digital skills and AI tools straightforwardness shape adoption behaviour among students (Rahman et al., 2025; Rahman Ismail et al., 2025).

As demonstrated in Figure 1, the proposed framework is designed to examine AI educational AI tools adoption among final-year students at Polytechnic Kota Kinabalu. It includes the core TAM variable of Perceived Ease of Use and Perceived Usefulness but also captures the significant social influence of (Subjective Norms) students experience from peers. Furthermore, it integrates individual technical proficiency (Tech Competency) and well-designed tools (Tech Simplicity), as students with higher technical skills are more likely to adopt AI chatbot (Rahman, Ismail, et al., 2025) and highly accessible AI tools inherently facilitate adoption (Rahman et al., 2025). Collectively, these factors strengthen students' intention to use AI tools and will subsequently drive actual adoption.

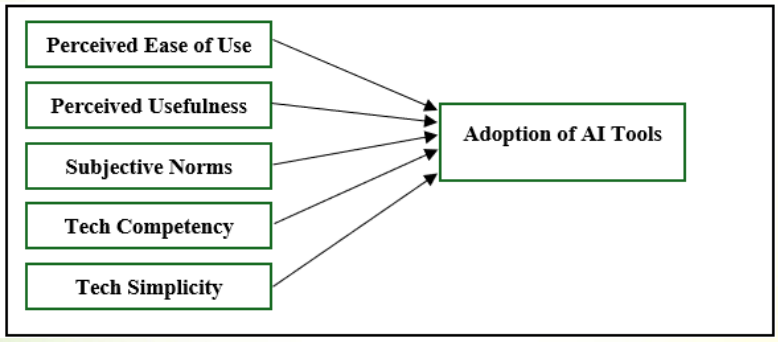


Fig. 1. Conceptual Framework

2.1 Artificial Intelligence Tools

Artificial intelligence is the simulation of human intelligence processes by machines which allowing them to interact with humans, influence behaviour and perform tasks beyond individual capabilities substantially producing content that almost similar to human response to difficult prompts. The learning environment in higher education is seeing rapid transformation due to AI, which serves as a supportive tool rather than taking over human roles. (Mustofa et al.,2025). AI tools are increasingly enhancing learning processes in education, offering personalized learning experience that are suited to students' unique needs and abilities through techniques such as machine learning and data analytics. (Aldreabi et al.,2025)

Examples of AI tools are AI chatbots and intelligent tutoring systems which provide students with immediate feedback, personalized learning help, automated answers and support for various tasks from writing essays and articles to translating, refining writing structure and brainstorming. (Rahman et al., 2025) The understanding of how students adopt AI tools is essential because their acceptance mainly determines success, fostering engagement, improving learning outcomes, and ensuring the effective integration of AI in educational settings. (Mustofa et al.,2025) AI's ability to boost student learning is consistent finding in resent studies with tools like ChatGPT being frequently used for assignments due to their effectiveness in providing reference, generating ideas and even answering complex questions. (Mustofa et al.,2025).

2.2 Hypothesis Development

a) Perceived Ease of Use and Adoption of AI Tools

Perceived Ease of use (PEoU) is one of fundamentals elements in *Technology acceptance model* (TAM) which refers to the degree of individual believes on using a particular system in terms of learning and operating it effectively (Mustofa et al.,2025; Aldreabi et al.,2025). Previous study shows that PEoU significantly influence the acceptance and adoption of new technology among the users. (Abulail et al., 2025). The findings highlight a positive correlation between perceived ease of use and student's willingness to use AI tools and chatbots with user-friendly interfaces and clear instructions enhancing engagement. (Rahman et al., 2025) When AI tools are seen as simple and easy to use by students, are more likely to be engaged with, their benefits are recognized and thus the willingness to adopt the technology is increased. (Aldreabi et al.,2025) Even though PEoU is a major element for adoption of AI tools, students who are already comfortable and familiar with this technology, usefulness become more prominent in shaping their long-term attitude towards the technology. (Rahman et al., 2025) In spite this diverse finding on the direct impact on attitude, PEoU is considered a key factor on with direct links to Ai chatbot capability and adoption intentions. (Aldreabi et al.,2025) Therefore, it is commonly believed Perceived Ease of Use positively influence students' Attitude Towards Using (ATU) AI tools, affects AI chatbot capability and contribute to the intention to use Generative AI (GenAI) tools, fundamentally encouraging AI adoption. (Mustofa et al. ,2025).

H1: Perceived Ease of Use has a significant positive effect on the Adoption of AI Tools.

b) Perceived Usefulness and Adoption of AI Tools

Perceived usefulness (PU) generally referred as a performance expectation indicates how much an individual believes that using a specific system will boost their job performance or productivity. This implies that the students believe AI tools can substantially enhance their academic performance and learning process. Various studies persistently highlight that perceived usefulness (PU) is a major factor influencing whether users accept and adopt technology. This positive view is essential since useful AI tools, such as AI chatbots and Generative AI (GenAI), can significantly improve learning outcomes by personalized learning experiences, instant feedback and individualized assistance. AI tools support a variety of academic task such as essay writing, composing articles, translating, refining writing structure, brainstorming ideas, generating paragraph, and answering complex questions. This nurtures critical thinking, boosts student engagement and enhance overall academic performance. It is

consistently hypothesized that Perceived Usefulness positively impacted students' intention to use AI tools, significantly influence their adoption, and contributing improved learning outcomes (Mustofa et al.,2025).

H2: Perceived Usefulness has a significant positive effect on the Adoption of AI Tools.

c) Subjective Norms and Adoption of AI Tools

According to (Mustofa et al.2025), subjective norms are the social pressures individual experience which significantly influence their acceptance and use of technology. In higher education, the willingness of students to use AI tools can be influenced by peers, instructors, and institutional policies. Many studies consistently emphasize that social influence is a significant contributor to use and adopt technology. A supportive environment for AI tools adoption is created when students perceived that their peers or teachers approve or anticipate the use of tools like ChatGP contribute to greater willingness to used them. This social support can create a sense of obligation and or motivation to integrate this tool into learning. The significant positive impact of subjective norms on students' intention to use AI chatbot application is explicitly supported by some research, such as a study on AI chatbot adoption in higher education. (Rahman et al., 2025) How ever in other research the findings are not consistent which indicated that subjective norms had no significant impact on AI chatbot capability (Rahman, Ismail, et al.,2025) or an unsupported quadratic effect on actual use (Mustofa et al.,2025) and even cases where subjective norms were not found important in adoption (Rahman, Ismail, et al.,2025). Nevertheless, it is generally hypothesized that Subjective norms positively influence students' intention to use AI tools, significantly affecting their adoption. (Rahman et al., 2025).

H3: Subjective Norms have a significant positive effect on the Adoption of AI Tools.

d) Tech Competency and Adoption of AI Tools

According to (King et al., 2017; Ruiz et al., 2022; Rahman, Ismail, et al. 2025), technology competency refers as digital skills or technology literacy, involves users' confidence, ability and understanding in effectively using, navigating and managing technology tools and process in practical scenario. Previous study results verify that strong digital skills significantly ease the adoption of ne technological tools like AI (Rahman et al., 2025). Also, students with higher technical literacy able to manage AI based learning tools easier to use and more suited to their needs and improving their confidence in using the AI tools (Ait Baha et al., 2024; Romero et al., 2020; Foroughi et al., 2025). This higher tech competency linked to greater productivity, engagement and interested in academic activities (Southworth et al., 2023; Singh et al., 2025). On the other hand, lack of technical expertise can create barrier among users to adopt the new technologies (Ait Baha et al., 2024). Literature consistently indicates that tech-savvy students are more likely to adopt AI tools and able to navigate interfaces, such as chatbots, with greater ease (Ait Baha et al., 2024; Nguyen et al., 2022). Similarly, Sahin Kizil et al. (2025) found that technological literacy enhanced the perceived usefulness of chatbot, which turn increased student's intention to used them. Rahman et al. (2025) also concluded that tech literacy has significant positive impact on student's intention to use AI chatbot application. These finding collectively reinforce that student's tech competency is more recognized their valuable assistance (Guan et al., 2025).

H4: Tech Competency has a significant positive effect on the Adoption of AI Tools.

e) Tech Simplicity and Adoption of AI Tools

Tech Simplicity generally known as Perceived Ease of Use (PEoU) describes how simple and easy an AI tools is perceived by users to learn and operate efficiently. An AI tools with clean, intuitive and user-friendly design is important because it is significantly reduced cognitive effort resulting students more willing to engage and integrate AI tools into their academic task. Various studies consistently demonstrate that students are significantly more likely to adopt AI tools when they're perceived easy to use. This ease of use, often due to a user-friendly interface and intuitive interaction, builds confidence and increases students' intention to use the tools. (Mustofa et al.,2025; Rahman et al., 2025) This simplified interaction eliminates obstacles, builds user confidence and attract interest resulting in increased technology utilization. (Rahman et al., 2025; Rahman, Ismail, et al.,2025) Although some studies indicate that perceived ease of used might be less crucial for students who are already tech-savvy, the majority evidence confirms that technology simplicity remain essential for both initial acceptance and ongoing engagement because it directly influences users' positive attitudes and willingness to integrate technologies into their learning (Rahman et al., 2025). Thus, it is consistently hypothesized that tech simplicity positively influences students' intention to use AI tools, significantly affecting their adoption (Mustofa et al.,2025).

H5: Tech Simplicity has a significant positive effect on the Adoption of AI Tools.

3.0 Methodology

This study employed a quantitative method with a combined descriptive and correlation design. Quantitative methods aim to understand social phenomena through measurable variables and data, and along with that, this method seeks to minimize biases and produce generalizable results by collecting numerical data using standardized instruments (Ghanad, 2023; Lim, 2024). This structured framework is geared toward hypothesis testing and generalizable insights (Lim, 2024). A descriptive design is suitable for identifying frequently utilized AI tools and the primary purposes, as its goal is "to accurately describe a population, situation, and phenomenon (Ghanad, 2023). At the same time, a correlation design was used to explore how different factors influence the use of AI tools, aiming to find out how changes in one factor can affect another without changing them. Ghanad, 2023). It "looks at the strength of the relationship (positive or negative) between two or more variables" (Wilson & Joye, 2016). This combined approach forms a descriptive-correlation study able to address description and relationship questions.

The convenience sampling technique will be adopted for participant selection. It involves drawing samples from that portion of the population which the study finds more accessible. (Ahmed, 2024). This non-probability sampling method is recognized for being fast, cheap and generally easier to implement for preliminary study (Elfil & Negida, 2016; Shorten & Moorley, 2014; Lim 2024). However, its is crucial to acknowledge that convenience sampling inherently carries a risk of selection bias. Therefore, the sample may not be representative and thus significantly limiting the generalization of the findings to the rest of the population (Ahmed, 2024; Lim 2024). For sample size determination, which is a vital in study for valid and reliable result, Yamane's Formula (n = N / (1 + N(e^2))) will be used (Ahmed, 2024; Altman, 1990). For a target population of 400 final year students, 95% confidence level, and 5 % margin of error (e=0.05), the calculated sample size is 200. This sample size is deemed sufficient to support the study's objectives and produce statistically significant results within

the context of the sampled population, while acknowledging the generalizability limitations posed by the chosen sampling method.

Study used a multi-section questionnaire, structured to gather comprehensive data on factors influencing the adoption of Artificial Intelligence (AI) tools among Polytechnic Kota Kinabalu final-year students. It comprises nine sections. Section A gathers information about the students, Section B identifies the AI tools they use most often, and Section C determines the main reasons they use AI educational tools. Sections D through I delve into the construct of the extended TAM, with Section D assessing perceived ease of use, adapted from Mustofa et al. 2025; Hazzan-Bishara et al.; Rahman, Ismail, et al. (2025); Section E measuring perceived usefulness (Mustofa et al. 2025; Hazzan-Bishara et al. 2025; Rahman et al. 2025); Section F for subjective Normas (Rahman et al. 2025; Rahman, Ismail, et al. 2025); Section G for tech competency (Rahman, Ismail, et al. 2025); Section H for tech simplicity (Rahman et al. 2025); and finally, Section I evaluating the dependent variable, adoption of AI tools (Rahman et al. 2025; Rahman, Ismail, et al. 2025). Data collection is scheduled to take place over one week, from 19 June to 26 June 2025, targeting the entire population of 400 final-year students engaged in industrial training.

Data analysis for this study will employ Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS 4.0 software, a robust technique suitable for predictive research and handling complex interrelationship among variables, as we as being tolerant of non-normal data distribution (Sarstedt et al., 2021; Mustofa et al. (2025). Descriptive statistics for demographic information will be analysed using IBM SPSS 26. The Analysis will proceed in two stages, first the measurement model (outer model) will be assessed for reliability and validity, examining indicator loadings (threshold > 0.7), Composite Reliability (CR>0.7), and Average Variance Extract (AVE>0.5) to ensure convergent validity (Hair et al., 2017; Garson 2016). While internal consistency will be confirmed with Cronbach's Alpha values exceeding 0.70. Discriminate validity will be evaluated using the Heterotrait-Monotrait (HTMT) ration values below 0.85 or 0.90 (Hair et al., 2019). Following this, the structural model (inner model) will be analyzed to test hypotheses relationships using a bootstrapping procedure with 5000 subsamples and evaluating predictive relevance via the Q^2 statistic value above 0.25 for strong predictive capability (Hair et al., 2019).

4.0 Results and Discussion

4.1 Demographic Finding

Table 1 shows the distribution of respondents by gender. The study found that the total number of male respondents was 105, which is 49.3%, and female respondents were 108, which is 50.7%.

Table 1 Distribution of respondents by gender

Gender	Frequency	Percentage (%)
Male	105	49.3
Female	108	50.7
Total	213	100.0

Table 2 shows the distribution of respondents according to the departments. The study found that the highest number of respondents was from the Department of Commerce (JP) with 123

respondents, which is 57.7%. Followed by the Department of Civil Engineering (JKA) and the Department of Electrical Engineering (JKE) each with 28 respondents, which is 13.1%. Then followed by the Department of Mechanical Engineering (JKM) and the Department of Tourism and Hospitality each with 17 respondents, which is 8%.

Table 2 Distribution of respondents by Department

Department	Frequency	Percentage (%)
Commerce Department (JP)	123	57.7
Civil Engineering Department (JKA)	28	13.1
Electrical Engineering Department (JKA)	28	13.1
Mechanical Engineering Department (JKM)	13	8.0
Tourism and Hospitality Department (JPH)	13	8.0
Total	**213**	**100.0**

Table 3 shows the distribution of students' academic achievements in terms of Cumulative Grade Point Average (CGPA). A total of 82 students fall within the CGPA range of 3.50–4.00, which corresponds to 38.5%. Meanwhile, 41.3% are within the CGPA range of 3.00–3.49. For the CGPA range of 2.50–2.99, there are 39 students. Lastly, the CGPA range of 2.00–2.49 accounts for 1.9%, which is 4 students.

Table 3 Distribution of respondents by CGPA

CGPA	Frequency	Percentage (%)
3.50 – 4.00	82	38.5
3.00 – 3.49	88	41.3
2.50 – 2.99	39	18.3
2.00 – 2.49	4	1.9
Total	**213**	**100.0**

4.2 Most Frequently Utilized AI Tools

Table 4 shows high number of AI tools usage among respondents with 207 students, which corresponds to 97.2% compared to only 2.8% stating they had never used AI tools in their learning.

Table 4 Distribution of respondents according to the use of AI tools in learning

Usage	Frequency	Percentage (%)
Yes	207	97.2
No	6	2.8
Total	213	100.0

Table 5 shows that, most respondent are actively utilize AI tools whereby 78.9% students are using AI Tools either daily or several times a week. 6.6% using AI tools once in a week and 13.1% respondent as rarely using AI tools. Only 2 people responded using AI Tools once in a month and 1 respondent never use AI Tools.

Table 5 Distribution of respondent AI Tools usage frequency

How often using AI Tools	Frequency	Percentage (%)
Daily	50	55.4

Several times a week	118	23.5
Once a week	14	6.6
Once a month	2	13.1
Rarely	28	0.9
Never	1	0.5
Total	213	100.0

From the study, the top ten (10) most frequently used AI tools among respondents are as per listed in Table 6. The most used AI Tools among students is Chat GPT with 98.6 respondent agree to use this AI Tools followed by Canva with 136 response which is 63.8%.

Table 6 Statistic of AI Tools Frequently use

AI Tools	**Frequency**	**Percentage (%)**
Chat GPT	210	98.6
Canva	136	63.8
Quill Bot	96	45.1
Gemini AI	69	32.4
Grammarly	51	23.9
DeepSeek	50	23.5
Microsoft copilot	20	9.4
PDF Chatbot	14	6.6
Design AI	12	5.6
Adobe Firefly	11	5.2

4.3 Primary Purpose of Utilizing AI-Driven Educational tools

Referring to the distribution of responses from study respondents, most agreed that the use of AI Tools in learning greatly contributed to improving writing, text translation and note taking. The statistics on the main purposes of using AI Tools are as shown in Table 7.

Table 7 Statistics of response for Primary Purpose of using AI Tools

Primary Purpose of using AI Tools	**Frequency**	**Percentage (%)**
Writing improvements	169	79.3
Translate	134	62.9
Note-taking	127	59.6
Grammar and proofreading	102	47.9
Presentation	100	46.9
Seeking advice or viewpoints	99	46.5
Generation study materials (e.g., Notes, quizzes, assignments)	96	45.1
Generating an image	83	39.0
Literature search	77	36.2
Data analysis and visualization	73	34.3
Plagiarism checking	68	31.9
Develop coding and programming	25	11.7
Paraphrase	22	10.3

4.4 Assessment of Measurement Model

In evaluating the measurement model, we conducted a comprehensive analysis to assess both convergent and discriminant validity. Convergent validity was examined to ensure that the indicators of each construct are sufficiently correlated, reflecting their ability to measure the same underlying concept. This was achieved by analyzing key metrics such as factor loadings, average variance extracted (AVE), and composite reliability. Discriminant validity, on the other hand, was evaluated to confirm that each construct is distinct from others in the model. This was assessed by comparing the square root of the AVE values with the inter-construct correlations, ensuring that the constructs exhibit sufficient uniqueness. Together, these evaluations provide a strong validation of the measurement reliability and accuracy of the model.

4.4.1 Convergent Validity

Table 8 presents the measurement model. Firstly, convergent validity and reliability of the model were analysed which represents factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR) of the variables. First, the factor loadings of all the loading for all items exceeds recommended value > 0.7. The factor loading is between 0.715 and 0.920. The AVE value for six of the variables were in the range of 0.653 to 0.811, that follow the recommended AVE value of more than 0.50. Meanwhile, the CR ranged from 0.764 to 0.884 that satisfies the requirements as it greater than the recommended value of being more than 0.70 given by (Hair et al., 2017; Garson 2016).

Table 8: Measurement Model Assessment

Constructs	Items	Loadings	CR	AVE
Perceived Ease of Use (PEoU)	PEoU 1	0.758	0.849	0.683
	PEoU 3	0.853		
	PEoU 5	0.838		
	PEoU 7	0.854		
Perceived Usefulness (PU)	PU 1	0.865	0.861	0.688
	PU 2	0.728		
	PU 5	0.885		
	PU 8	0.830		
Subject Norm (SN)	SN 1	0.803	0.831	0.653
	SN 2	0.715		
	SN 3	0.827		
	SN 4	0.879		
Tech Competency (TC)	TC 1	0.861	0.814	0.711
	TC 2	0.813		
	TC 3	0.855		
Tech Simplicity (TS)	PI 1	0.914	0.764	0.793
	PI 3	0.866		
Adoption of AI Tools (AAT)	PI 1	0.904	0.884	0.811
	PI 4	0.920		
	PI 6	0.878		

CR: Composite Reliability; AVE: Average Variance Extracted

4.4.2 Discriminant Validity

According to (Kock, 2014; 2015; 2020b; Kock & Lynn, 2012), discriminant validity is the state in which each construct in a theoretical framework is distinct from all other constructs. By utilizing the Heterotrait-Monotrait Ratio (HTMT) to analyze correlations between measurements of possibly overlapping constructs, the discriminant validity of the model was evaluated. According to (Hair et al. 2019), The main goal of this discriminant validity assessment was to make sure that construct in the PLS path model showed the strongest association with its own indicators in comparison to every other construct in the model. Table 4 present the data, which shows that all constructions HTMT values are consistently below the 0.85 or 0.90 criterion. This important result confirms the dependability and validity of the research and successfully supports the conclusion that the study model has reached the necessary level of discriminant validity (Hair et al., 2019).

Table 9: Discriminant Validity ($HTMT_{.85}$)

	AAIT	GIF	PEU	PI	PU
AAIT					
PEoU	0.814				
PU	0.815	0.841			
SN	0.756	0.655	0.713		
TC	0.725	0.693	0.644	0.642	
TS	0.849	0.830	0.740	0.726	0.760

4.4.3 Structural Model and Hypotheses

As part of the computation of the structural model and hypothesis, we measured the hypothesis test, R^2 value, and the predictive accuracy of the PLS path model (Q2). The hypothesis test helps to determine if the relationship between variables is statistically significant. The R^2 value helps to measure how much of the data variation is explained by the model, and the Q^2 value helps to measure how well the model predicts future data. This is a significant assessment to examine the goodness of the structural model (Hair et al., 2019).

SmartPLS requires a structural equation model after the computing measurement model. All hypotheses for direct links were supported by the results of Table 10. The R^2 value of 0.687 indicates that approximately 68.7% of the variance in the adoption of AI tools can be explained by the combined influence of Perceived Ease of Use, Perceived Usefulness, Subject Norm, Tech competency and Tech simplicity. Additionally, the Q^2 is an estimate of the predictive ability of the model and is calculated via cross-validation (CV). Q^2 is used to assess predictive validity in a PLS model using the blindfolding process. According to Hair et al. (2019), a Q^2 value greater than zero indicates that external variables have predictive relevance to endogenous variables. This is supported further by the fact that the Q^2 value for the endogenous variable, purchase intention (Q2=0.541), above zero, confirming the model's predictive relevance in capturing the link between these variables. This value exceeds the benchmark for strong predictive capability, suggesting that the model not only fits the observed data well but is also effective in predicting the adoption behaviour of students in similar contexts.

Moreover, the result of the hypothesis testing in table 10, revealed that four out of five proposed factors significantly influenced the adoption of AI tools among Kota Kinabalu Polytechnics students. Tech Simplicity emerged as the strongest predictor (β= 0.303, $p< 0.000$), indicating that students are more likely to adopt AI tools that are straightforward and easy to navigate.

Perceived usefulness also shows a significant positive effect (β= 0.245, p< 0.009), suggesting that student is motivated to used AI tools when they believe these tools enhance their academic performance. Subject Norma (β= 0.178, p< 0.028) and Tech Competency (β= 0.120, p< 0.033) were also supported, highlighting the importance of social influenced and digital skills in technology adoption. However, Perceived Ease of Use did not show a significant effect (β= 0.157, p< 0.064), indicating that ease alone may not be enough to drive adoption unless the tools are also seen as useful or simple. Overall, the finding emphasized that both functionality and simplicity play key roles in encouraging the use of AI tools in an educational setting.

Table 10: Hypotheses Testing Results

Hypotheses	Relationships	Path Coefficients	$t-$ Values	p- Values	Decisions
Main Model					
H1	PEoU -> AAIT	0.157	1.851	0.064	Not Supported
H2	PU -> AAIT	0.245	2.615	0.009**	Supported
H3	SN -> AAIT	0.178	2.193	0.028*	Supported
H4	TC -> AAIT	0.120	2.131	0.033*	Supported
H5	TS -> AAIT	0.303	3.952	0.000***	Supported

Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (one-tail)

5.0 Discussion

A significant finding was that the relationship between perceived ease of use and the adoption of educational AI tools was not supported (H1). The finding surprising because it goes against the original Technology Acceptance Model (TAM), Where PEoU is traditionally a core determinant of technology acceptance (Mustofa et al., 2022; Sukirman & Fitriningtyas, 2021, pp. 153–157). However, this result aligns with some recent literature suggesting that for today's students, often described as "technology savvy" and "familiar with technology", the mere wase of using AI technology may no longer be a primary factor influencing their attitude (Mustofa et al. 2025). This might be because students are more focused on the usefulness aspect of AI tools, prioritizing learning outcome over mere simplicity. While this finding aligns with some new research, it contrasts with may past studies that still view ease of use as a key influence on technology adoption (Foroughi et al. 2024; Abulail et al., 2025). This difference suggests that the importance of PEoU may depend on context. For students who already have a basic level of digital literacy, ease of use may be expected as a standard feature, not key reason for adoption.

Perceived usefulness (PU) was strongly supported as significant factor (H2). This clearly shows that students adopt AI tools when they believe these tools genuinely improve their academic work. This finding is very consistent with existing studies on technology adoptions, especially the TAM, which states that PU is a major predictor of technology acceptance in several areas (Chai et al., 2020; Mustofa et al. 2025). Students are motivated to use AI tools like ChatGPT for task such as finding different viewpoints, quick task adaptability, completing assignments and improving the writing structure (Baskara et al., 2023; Ray 2023). They view these tools useful and effective for their learning process. They see these tools as effective and helpful for their learning process. The ability of AI to offer personalized learning, quick responses, and adaptive assessment also boosting academic performance. In student's viewpoint AI tools as beneficial to their studies, which increase willingness to use then in educational environments (Al-Mamary et al. 2024; Rasul et al., 2023; Kılınç, 2023). Overall, the finding of this study

confirm that students are more willing to use educational AI tools when they consider the tools useful for improving their learning outcomes.

Besides that, Subjective Norma (SN) was found to be a significant factor (H3). This indicating that influence from peers or lecturers encourages students to adopt AI tools. This finding matches previous research that emphasizes the important role of social influence in students' willingness to use AI tools (Islam et al. 2024; Rahman et al. 2025). When students feel that their classmates or lecturer approved of AI tool usage, there are more likely to use these tools in their academic activities (Rahman et al. 2025). This pattern also suggests that peers, educators, and educational institutions should make it easier for students to use AI tools to boost their motivation and trust in usage of AI tools. However, it's worth nothing that some studies, particularly those on AI chatbot adoption, have found that subjective norms did not have a significant effect on implying that in those situations, users might prioritize the tools functions and usability over social expectations (Rahman Ismail, et al. 2025; Mustofa et al. 2025). Therefore, while social influence matters, its impact may depend on context. Experience or outcome driven students may rely more on a tool's usefulness than on other opinion. A balance approach that combines social support with practical values is essential to encourage meaningful and sustained AI tools adoption.

Tech Competency (TC) was found to be a significant factor influencing adoption of educational AI tools (H4). This indicate that students who feel more confident and skilled with technology are more likely to use AI tools in their academic work. The finding aligns with Rahman et al. (2025), who reported that tech-savvy students tend to show stronger intention to adopt digital tools in higher education. Similarly, studies by Southworth et al. (2023) and Singh et al. (2025) emphasize that digital literacy enhance students' ability to effectively integrate AI into their learning, boosting productivity and engagement. Therefore, its importance to providing structured training in both AI and digital skills to increase students' readiness and confidence. Moreover, tech competency instructor is more likely to embrace AI in their teaching, although barriers like limited resources may affected their readiness. Ultimately, the finding suggest that technology confidence is not only a personal asset but a critical foundation for effective AI adoption. Institution must recognize that without investing in digital competence both students and lecturers the full potential of AI tools in education may remain underutilized.

Most importantly, this study found Tech Simplicity (TS) to be the most powerful factor influencing adoption of educational AI tools (H5). This explain that an AI tools that simple and easy to be used significantly increase the change of its adoption among users. This aligns with (Rahman et al. 2025), who found that simplicity significantly influence students' intention to use AI chatbot. Similarly, Tian et al. (2024) noted that students are more willing to engage with AI tools when interactions feel effortless and easy to accessible. Together, these studies and the current findings suggest that tech simplicity of AI tools will reduce barriers to engagement, increase usability and foster meaningful interaction which is making it the most critical factor in promotion AI tools adoption. Therefore, for AI tools to be effectively integrated into higher education, designers and institutions must prioritize user-centered design that emphasizes simplicity, clarity, and ease of access.

6.0 Theoretical Contribution

This study extends the Technology Acceptance Model (TAM)) by integrating tech simplicity, and tech competency, thereby providing a holistic framework for understanding AI adoption in Technical and Vocational Education and Training institutions environment. The findings

empirically reveal that tech simplicity character of educational AI tools beyond perceived ease of use, most significant factor influencing AI tools adoption among Polytechnic Kota Kinabalu students. Especially, the result challenge conventional TAM assumptions by revealing that perceived ease of use does not significantly predict adoption in this context. By positioning the analysis within the unique andragogical and practical environment of Malaysia Polytechnic, this study addresses a critical gap in the literature. Overall, this study enhances theoretical discourse by explaining the complex interplay between individual, social and technology factors in shaping AI tools adoption behaviour in vocational education settings.

7.0 Practical Contribution

Based on the findings of this study, several practical contributions and recommendations are relevant for lecturers, higher education institutions, AI developers, and the Ministry of Higher Education (MOHE) Malaysia in advancing the effective adoption of AI tools in academic settings. The strong influence of tech simplicity highlights the importance of designing AI tools with intuitive, user-friendly interfaces that reduce cognitive barriers and support sustained engagement. The significant role of tech competency and subjective norms suggests that the importance of institutional initiatives lies in strengthening students' digital literacy and fostering a supportive learning culture through peer and lecturer engagement. For MOHE, the finding highlights the necessity of establishing a national framework for AI integration in TVET education, which may include targeted funding, the implementation of a standardised AI literacy programme across institutions, and the development of comprehensive policies that address responsible, ethical, and inclusive AI usage in the teaching and learning process. An example can be found in Singapore, where HCLTech partnered with Singapore Polytechnic (SP) and Nanyang Polytechnic (NYP) to establish an artificial intelligence laboratory. The lab trains students and mid-career professionals in generative AI, preparing them for jobs in AI-driven industries. This shows how partnerships between education and industry can make AI adoption in TVET more effective. Malaysia could take a similar approach to strengthen AI use in polytechnics. Additionally, AI developers should focus on designing AI tools that are not only well-functioning but also ethically responsible and align with the diverse educational contexts across the globe. Collectively, the continuous evaluation of AI's tools' impact on learning outcomes, along with partnership with technology providers and international bodies, will help Malaysia be at the forefront of educational innovation while ensuring that AI integration meets the diverse needs of all stakeholders in the education industry.

8.0 Limitation and Future Work

This study identifies several limitations that should be solved in future studies. First, this study used convenience sampling and focused on final year students at Polytechnic Kota Kinabalu, which this approach will limits the generalizability of the findings to other higher institutions or regions. To address this limitation and enhance the understanding, future studies should use probability sampling and include participant from multiple TVET institutions across Borneo or throughout Malaysia. This approach will capture broad and diverse representative perception. Second, this study only explored five independent variables, but there are many more variables that could potentially influence educational AI tools adoption among students, such as motivations, user satisfaction, trust, data privacy concerns, institutional support or policy frameworks. Therefore, in future work could expand the model to lead more comprehensive understanding of educational AI tools adoption dynamics within TVET settings.

9.0 Conclusion

The study successfully applies the extended Technology Acceptance Model (TAM) to understanding into the factors influencing educational AI tools adopting among Polytechnic Kota Kinabalu students. The results show that all hypotheses are accepted except perceived ease of use. Finding highlight the important role of perceived usefulness, subjective norms, tech competency and tech simplicity in shaping adoption behaviour among students. As a conclusion successful AI integration in educational environments depends not just on technology access, but on how well these AI tools support and enhance the learning experience. This empirical evidence provides guidance for enhancing AI adoption among the TVET landscape across Malaysia.

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The Role of Academic Advisors in Shaping Student Performance and Engagement in Mentoring Classes

Adwina Vali @ Galus[1*], Nina Shenna Kosumin[2], Fredoline Galambun[3]

[1,2,3]Department of Tourism and Hospitality Politeknik Kota Kinabalu (PKK) No. 4, Jalan Politeknik KKIP Barat Kota Kinabalu Industrial Park 88460 Kota Kinabalu Sabah

*adwina@polikk.edu.my

Abstract

Mentoring plays an important role in shaping how students perform and stay engaged in their studies. This is especially true in mentoring classes where academic advisors act as key figures. The importance of mentoring is widely acknowledged. However, there's still a lot that needs to be fully understood about the impact of these advisors on student outcomes. This study aims to examine how the academic advisors influence students' academic progress and engagement during mentoring sessions. A systematic literature review was carried out, concentrating on peer-reviewed research from previous studies that focus on advising, mentoring, student performance, and engagement. The findings reveal that advising should not be considered as uniform performance. Instead, the quality of the advisor-student relationship strongly influences students' motivation, confidence and dedication to their study's aims. Effective advising significantly improves academic achievement and engagement. In contrast, mentoring that appears to be highly operational results in students feeling discouraged and isolated from their academic path. A major discovery is the impact of external factors such as the emergence of digital mentoring platforms and diverse institutional practices. External factors are constantly affecting the implementation and perception of advising. At some point, academic advising surpasses simple task completion. It is an ongoing procedure that includes both interpersonal connections and a systematic approach. To be fully effective, advisors need sufficient training and resources to facilitate the development of meaningful relationships with the students. When such things happen, institutions can better assist students in directing their academic paths and achieving success.

Keywords: *Academic advising; Student performance; Student engagement; Mentoring in higher education*

1. Introduction

Academic advising is recognized as a crucial component of student support services in higher education. It serves as an essential connection between academic planning and personal development by assisting students in course selection and in defining their educational trajectories and long-term career objectives (Iatrellis et al., 2017). The scope of advising has broadened from administrative counsel to encompass relational and developmental elements that foster significant connections between advisers and students. These relationships are essential for fostering academic resilience, elucidating students' aspirations and maintaining engagement over time (Smith, 2020; Nguyen, 2020). Recent findings underscore the significance of scaffolding and deliberate mentoring approaches in cultivating resilience, especially for first-year students undergoing post-pandemic transitions (Gray et al., 2024)

The transfer to higher education poses several hurdles for students that can impact their persistence and success (Johnson & Lee, 2019). Academic advising functions as a systematic intervention to assist students in navigating these challenges through deliberate support (McLean et al., 2022). Customised and developmentally suitable advising improves outcomes, including learning, retention and a sense of belonging within academic groups (Brown, 2021; Garcia, 2018). Effective faculty advising is correlated with enhanced student involvement and academic achievement (Jamaludin et al., 2025). In response, numerous universities are implementing holistic advising models that prioritize proactive and adaptable strategies, particularly for non-traditional student demographics (Stamou, 2024).

Mentoring sessions offer a structured type of assistance, delivering continuous, personalised attention and the development of transferable skills (Williams, 2017; Lopez, 2021). Studies demonstrate that peer mentorship enhances a sense of belonging and diminishes attrition, with one investigation reporting a transfer rate under 2% (Lapon et al., 2024). Digital mentoring services such as *MentorHu*b illustrate how technology may enhance the accessibility of advising by linking the students with resources and timely referrals (Bussu & Burton, 2023). Although the significance of academic advising in enhancing student performance and engagement is well recognized, there has been insufficient focus on how particular advisor behaviours, mentoring tactics, and interpersonal interaction affect outcomes in mentoring environments. The availability of students predominantly emphasizes institutional or structural constraints, such as advisor workload and limited resources. However, the dynamic interactions that directly influence motivation, persistence and success are inadequately examined. This gap necessitates a thorough analysis of the process and interaction that characterize good advising, especially within formal mentoring courses.

This study examines the influence of academic advisers on student performance and participation within mentorship contexts. This study is guided by two central research questions: How do academic advisors influence student academic performance and engagement in mentoring environments? and What are the challenges and barriers in academic advising? To address these questions, the study pursues two objectives. The first objective is to synthesize empirical evidence on the role of academic advisors in shaping student performance and engagement within mentoring classes. Whereas the second is to identify the challenges and barriers in academic advising. By systematically reviewing the literature, this study seeks to advance understanding of the advisor's role in mentoring and to inform the development of more effective advising models in higher education settings.

2. Literature Review

2.1 Academic Advisors

Academic advisors play an essential role in supporting students' academic journeys. This is conducted by offering personalized guidance, guiding decision-making, and connecting students with institutional resources (Drake, 2011). Effective academic advising is more than executing administrative tasks but includes developmental functions such as mentoring, coaching, and fostering a supportive learning environment (Williams, 2017). The advisor-student relationship is central to this process. Critical determinants of advising effectiveness are related to qualities that are characterized by trust, empathy, and open communication (Garcia, 2018). Advisors who actively listen and respond to students' academic and personal concerns contribute to increased student satisfaction and utilization of advising services (Lopez, 2021). More recent work emphasizes that proactive and holistic advising models are increasingly institutionalized, with equity-driven frameworks and wraparound services improving access and retention (Stamou, 2024). At the same time, institutions are experimenting with AI-based tools, such as conversational agents, to extend advisor capacity and student reach (Mughal et al., 2025). Despite these challenges, many faculty members view academic advising as a core component of their professional responsibilities, aligning it closely with their teaching roles and educational mission (Hart-Baldridge, 2020).

2.2 Student Performance

Student performance is commonly measured through indicators such as grade point average (GPA), course completion rates, and retention. It is a key outcome influenced by academic advising (Chan et al., 2019). Numerous studies have shown that students who receive consistent, proactive, and personalized advising demonstrate improved academic outcomes compared to their peers without such support (Nguyen, 2020). Similarly, proactive advising conducted by advisors such as establishing contact and monitoring student progress, has been linked to reductions in academic decline and increased perseverance (Tippetts et al., 2020). Structured advising programs, including mentoring interventions, have also been associated with notable improvements in pass rates and reduced dropout rates, particularly among first-generation and at-risk students (Masehela & Mabika, 2017). Recent studies suggest that data-driven advising dashboards can enhance these interventions by enabling advisors to proactively monitor academic risks and personalize support (Vemula & Moraes, 2024). These findings highlight the critical role of advising in shaping students' academic trajectories and long-term success.

2.3 Student Engagement in Mentoring Classes

Mentoring classes provide a unique environment for fostering student engagement. These involve behavioural, emotional, and cognitive involvement in learning activities (Chan et al., 2019). Academic advisors facilitate engagement by promoting reflective learning, encouraging active participation, and addressing individual student needs (Lopez, 2021). Students who perceive their advisors as approachable and supportive tend to exhibit higher levels of motivation, self-efficacy, and academic involvement (Garcia, 2018; Williams, 2017). Furthermore, a stronger sense of academic belonging and agency among students is created through mentoring sessions that integrate interactive exercises and meaningful advisor-student dialogues (Afzal et al., 2024). However, limited advisor capacity and role ambiguity remain as challenges in optimizing student engagement within these settings (Hart-Baldridge, 2020; Lunsford et al., 2017). Research shows that mobile-device-based peer mentoring programs significantly enhance community building, active learning, and overall academic experience among first-year students (Bussu & Burton, 2023).

3. Methodology

A systematic literature review was performed following the PRISMA 2020 standards (Page et al., 2021). The preliminary database search yielded 134 records. After deleting 20 duplicates, 114 articles were screened by title and abstract. Of these, 39 were omitted for not focusing on higher education advising or mentoring, while 30 were excluded for lacking empirical data. A total of 45 studies fulfilled all qualifying criteria and were incorporated into the final review. Exclusion criteria encompassed unsuitable populations (e.g., primary/ secondary school samples), conceptual-only manuscripts, and studies conducted outside the 2015-2025 period, which led to the exclusion of 69 studies. Figure 1 displays the PRISMA flow diagram, providing comprehensive counts at each stage. A meta-analysis was deemed impractical due to the variability in study designs, metrics of student performance, and varieties of advising interventions. In accordance with the recommendations of Page et al. (2021), a narrative synthesis methodology was employed to integrate diverse findings and identify common themes and conceptual patterns across studies. The final sample represents around 34% of the total records identified, which aligns with common ratios observed in educational

and social science systematic reviews (Moher et al., 2009). While this restricts generalizability, it offers nuanced into advising procedures across diverse institutional contexts.

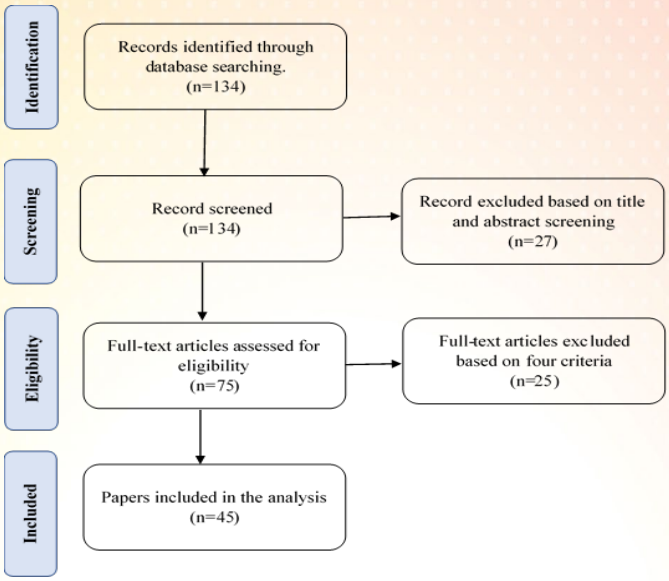


Figure 1:
Literature search procedure based on PRISMA guideline.

To ensure consistency in how information was captured, a structured coding system was created. Each article was examined for details such as the year of publication, country of study, research design, sample profile, nature of the advising or mentoring practice, reported student outcomes, and any noted challenges or limitations. In order to minimize subjectivity during data extraction, two researchers independently reviewed all selected articles. Any differences in interpretation were resolved through discussion and consensus. Studies that demonstrated unclear descriptions or inadequate methodological quality were not included to maintain the reliability of the synthesis. The analysis was carried out using a narrative synthesis approach. This process facilitated the discovery of recurring themes and concepts throughout the reviewed literature, without reliance on quantitative meta-analysis. The study's findings were categorized into two primary themes. First, the impact of academic advisers on student performance and engagement in mentoring classes. Second, the prevalent challenges and constraints encountered in the practice of academic advising.

4. Findings

A total of 45 papers were included in this systematic review. The findings reveal numerous key findings about the impact of academic advisors in affecting student performance and engagement within mentoring classes.

4.1 The Role of Academic Advisors in Shaping Student Performance and Engagement in Mentoring Classes

Findings reveal the significant role of academic advisors in facilitating the students' performance and engagement. Advising involves more than simply helping students with course registration or managing administrative duties. It involves assisting students with academic challenges, offering emotional support and linking them to relevant resources and

opportunities on campus. Numerous studies underscore the importance of a dynamic interaction between advisers and students. William (2017) believes that trust and transparent communication are fundamental components of good academic advising. Garcia (2018) similarly discovers that when advisors offer personalised counsel aligned with the students' specific goals and challenges, students have increased confidence and better ability to plan their academic paths. Lopez (2021) asserts that empathy and attentive listening skills enhance advisers' ability to address students' unique situations. This results in enhanced satisfaction and elevated engagement with advisory services.

Academic guidance correlates with enhanced academic success. Moreover, it enhances interpersonal ties during mentorship sessions. Numerous studies have demonstrated substantial enhancements in students' performance, including CGPA, retention rates and graduation rates. Nguyen (2020) stated that students who received individualized and consistent advising outperformed their peers who did not. Similarly, Kumar and Patel (2019) found that students who proactively engaged in advising sessions were less likely to experience academic difficulties and were more likely to remain enrolled. Tippetts et al. (2020) found that students who maintained consistent relationships with their advisors were more likely to complete their academic programs. Mentoring programs have been shown to be particularly beneficial for first-generation students and those at risk of dropping out. It has been documented that mentoring supports academic persistence in this group (Masehela and Mabika, 2017). Meanwhile, Bagaka et al. (2015) found that ongoing advising helps students build a stronger academic identity and a deeper commitment to completing their studies.

Another consistent theme is the impact of academic advising on students' engagement. Lopez (2021) describes advising classes are spaces that encourage open dialogue and personal reflection. This, in turn, encourages students to be more engaged in their learning process. Garcia (2018) emphasizes that students are more likely to feel a sense of belonging and take responsibility for their academic journey when they receive ongoing support from their advisors. Williams (2017) further adds that students are more motivated to participate when they perceive their advisors as approachable and trustworthy. Similarly, Taylor (2022) contended that positive relationships between advisors and students can increase intrinsic motivation. Structured advising programs also help students maintain their academic focus and direction Afzal et al. (2024). Timely feedback and clear communication in maintaining student engagement throughout the semester was also emphasized by He and Hutson (2016).

In addition, integrated advising models that combine academic guidance with support services such as academic tutoring, career counselling, and early intervention have been found to be particularly effective. Studies by Zhang et al. (2019), Sneyers and De Witte (2018), and Tudor (2018) all demonstrate the added value of holistic advising in improving student performance and engagement. However, DeAngelo et al. (2016) caution that the success of such programs is highly dependent on institutional support, and the quality of advisor training. Overall, the findings of this study suggest that academic advising is most effective when it is proactive, student-centred, and supported by adequate institutional resources. Advisors who build meaningful relationships and provide personalized guidance can have a significant impact on students' academic success and engagement.

4.2 Challenges and Barriers in Academic Advising

The successful outcome of academic mentoring can often be undermined by persistent institutional obstacles. A common concern is the elevated advisor-to-student ratio, which constrains alternatives for individualised, one-to-one support. Advising sessions often become

rushed and administrative, prioritizing course selection over substantive academic guidance (Chen & Roberts, 2023). Lecturers who undertake advising duties also have challenges in combining their responsibilities with their advising roles (Patel & Thomas, 2018). This frequently leads to inconsistencies in the quality and frequency of advising interactions. Technology brings another level of complexity to the advising process. Digital platforms provide different ways for students and advisers to maintain connectivity, particularly beyond conventional office hours. Nevertheless, such tools are not consistently used to their full potential. Some students gave up virtual mentoring possibilities due to uncertain execution, while others may lack a comprehensive understanding of the objectives of academic advising or fail to acknowledge its significance (Chen & Roberts, 2023; Patel & Thomas, 2018). This lack of understanding affects the students' progress and engagement, which could result in the underutilization of advising services.

Perceptual challenges also contribute significantly. Students recognize the significance of academic advising. However, they remain unsure about how to obtain assistance or actively participate in the process (Afzal et al., 2024). Moreover, advisers frequently express dissatisfaction stemming from excessive workloads and ambiguous institutional expectations. This undermines their capacity to offer substantive recommendations (Hart-Baldridge, 2020). The absence of standardized advising procedure hinders the formation of effective, goal-oriented relationships with students (Lunsford et al., 2017). To enhance outcomes, institutions must invest in clearer designations of the adviser's role, specialized training for advisors, more efficient utilization of digital tools, and student education regarding the objectives and advantages of academic advising. These measures are essential for enhancing the efficacy and responsiveness of advising services to students' requirements.

5. Discussion, Contribution, Limitation and Conclusion

This systematic review highlights several different functions that academic advisers fulfil in mentorship courses. While advising once centred on administrative support, it now extends to developmental assistance that shapes students' academic decisions, trajectories, and problem-solving capacity (Williams, 2017; Collier, 2017; Lopez, 2021). In addition to enhancing immediate results like GPA or retention, advising fosters a sense of belonging and academic identity, which are essential for sustained persistence. This indicates that educational institutions ought to regard advising as an investment in student development rather than merely an administrative service. In addition to exploring positive impacts, this review brings attention to structural and institutional barriers that hinder the effectiveness of advising practices. As explained by Chen & Roberts (2023) and Patel & Thomas (2018), high advisor-to-student ratios continue to limit opportunities for meaningful interaction and many institutions still provide little training in developmental or student-centred advising models. Furthermore, while digital tools could enhance advising accessibility and efficiency, they remain inconsistently implemented.

Recent innovations, such as AI-driven conversational agents (Mughal et al., 2025), AI-powered course advising systems like SmartCourse (Mi et al., 2025), and learning analytics dashboards (Vemula & Moraes, 2024), demonstrate promising ways to improve personalization and scalability of advising services. This points to a broader gap in empirical research on how technological interventions can be designed and implemented to improve advising outcomes across different student populations. The results of this review also possess theoretical implications. Emerging digital advising tools also introduce new dynamics, where advisor-student interactions may be mediated by AI systems. This raises theoretical questions

about how self-efficacy and motivation are influenced when guidance is delivered through hybrid human–AI models, an area that requires further research (Stamou, 2024; Mughal et al., 2025). Moreover, the evidence substantiates developmental advising theories (Crookston, 1972; Drake, 2011), which assert that good advising transcends administrative duties and encompasses comprehensive student development. This review synthesizes several views to provide a comprehensive understanding of advising as a relational and developmental process that influences performance and participation in mentoring environments.

Another gap lies in how the field measures the quality of advisor-student relationships and their long-term effects. There is little consensus on how to evaluate the qualitative, interpersonal aspects of the advising experience, despite the impact of advising on academic metrics is well reported. However, more work is needed to understand how these experiences translate into lasting academic and personal growth. As Creswell and Plano Clark (2017) and Harrison et al. (2024) have suggested, future research would benefit from longitudinal and mixed-methods approaches. These designs can provide deeper insight into not just whether advising is effective, but how and why it works in diverse mentoring contexts. This study contributes to the literature by offering an integrated synthesis focused specifically on academic advising within mentoring classes. It is an area that has received limited direct attention in prior research. The review connects theoretical insights with empirical findings, demonstrating how advising fosters student growth. This study also identifies institutional and structural factors that inhibit its full potential. The insights are particularly relevant for institutional leaders, educators, and policymakers seeking to improve student support services through more effective advising systems.

The study nevertheless has several limitations. It includes only peer-reviewed empirical research published between 2015 and 2025, disregarding grey literature and older foundational studies that may offer additional insights. Furthermore, many of the reviewed studies were based in specific institutional or regional settings, which may limit generalizability. The use of narrative synthesis, rather than statistical meta-analysis, also constrains the ability to quantify relationships between advising practices and outcomes. Future studies should also assess the long-term effectiveness of AI-driven advising tools, digital mentoring platforms, and equity-focused advising frameworks in improving student performance and engagement across diverse populations (Vemula & Moraes, 2024; Stamou, 2024). There is also a need to examine the impact of advising on diverse student populations, such as first-generation and international students. Overall, the findings of this review point up the significance of academic advising in mentoring environments and provide a strong foundation for improving practice, informing policy, and guiding future research.

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LAPORAN PENILAIAN OBJEKTIF PENDIDIKAN PROGRAM (PEO) BAGI GRADUAN PROGRAM DIPLOMA KEJURUTERAAN AWAM (DKA) DI POLITEKNIK KOTA KINABALU

Hamizulanuar bin Abu Bakar[1*], Dr. Mohd Isa bin Jaffar[2], Siti Nurakmal bin Mohd Yusoff[3]

[1,2,3]Civil Engineering Department, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

*hamizulanuar@polikk.edu.my

Abstract

Achievement of Program Educational Objectives (PEO) is a requirement and is used as an evaluation indicator for every study program in higher education institutions. It is a mandatory element for the accreditation process of a study program according to the regulations of the Engineering Technology Accreditation Council (ETAC) and the Malaysian Qualification Agency (MQA). Therefore, this study is an evaluation of the PEO for the Civil Engineering Diploma Program (DKA) at Kota Kinabalu Polytechnic (PKK) which uses the DKA Curriculum Version 2014. This study was also carried out to assess the career development of DKA graduates, and subsequently to assess the achievement of the Program Educational Objectives (PEO) which was monitored indirectly through a survey of alumni and employers from related companies. A questionnaire (Google Form) was used as a research instrument using a Likert scale on a scale of 1 to 5, with 1 being poor and 5 being excellent. The results of the study found that the average PEO 1 achievement score was 75 percent, PEO 2 achievement was at a high level of 82 percent while PEO 3 showed the highest average score of 86 percent and the average score for PEO 4 was 80 percent. Overall, it was found that the average PEO score for the DKA program was successfully achieved in excess of 75 percent and the analysis results showed that the DKA program was found to be effective in improving the relevance of the program with the industry, as well as the career development of graduates.

Keywords: *Program Education Objectives (PEO); Diploma in Civil Engineering; Kota Kinabalu Polytechnic; graduates.*

Abstrak

Pencapaian Objektif Pendidikan Program (PEO) merupakan satu keperluan dan dijadikan sebagai indikator penilaian bagi setiap program pengajian di institusi pengajian tinggi. Ianya merupakan elemen wajib bagi proses akreditasi sesebuah program pengajian mengikut ketetapan Engineering Technology Accreditation Council (ETAC) dan Agensi Kelayakan Malaysia (MQA). Justeru, kajian ini merupakan penilaian pencapaian terhadap PEO bagi Program Diploma Kejuruteraan Awam (DKA) di Politeknik Kota Kinabalu (PKK) yang menggunapakai Kurikulum DKA Versi 2014. Kajian ini juga dijalankan adalah untuk menilai perkembangan kerjaya graduan DKA, dan seterusnya membuat penilaian terhadap pencapaian Objektif Pendidikan Program (PEO) yang dipantau secara tidak langsung melalui tinjauan alumni dan majikan dari syarikat yang berkaitan. Borang soal selidik secara dalam talian digunakan sebagai instrumen kajian utama dengan menggunakan skala Likert pada skala 1 hingga 5, dengan 1 adalah lemah dan 5 adalah cemerlang. Hasil daripada kajian mendapati bahawa purata peratusan skor bagi pencapaian PEO 1 adalah sebanyak 75 peratus, pencapaian PEO 2 adalah 82 peratus manakala PEO 3 menunjukkan purata skor tertinggi iaitu sebanyak 86 peratus dan purata skor bagi PEO 4 adalah sebanyak 80 peratus. Secara keseluruhannya nilai purata peratusan skor PEO bagi program DKA berjaya dicapai melebihi 75 peratus dan hasil analisis menunjukkan program DKA didapati berkesan dalam mempertingkatkan kerelevanan program dengan industri, serta pembangunan kerjaya graduan.

Kata Kunci*: Objektif Pendidikan Program (PEO); Diploma Kejuruteraan Awam; Politeknik Kota Kinabalu; graduan.*

1.0 PENGENALAN

Reka bentuk kurikulum bagi suatu program pengajian di politeknik adalah berdasarkan pendekatan Pembelajaran Berasaskan Hasil (OBE) yang memfokuskan kepada beberapa keperluan pencapaian seperti Objektif Pendidikan Program (PEO), Hasil Pembelajaran Program (PLO) dan Hasil Pembelajaran Kursus (CLO). Elemen ini perlu mematuhi garis panduan standard program Diploma dan Kerangka Kelayakan Malaysia yang telah ditetapkan. Merujuk kepada Garis Panduan Pelaksanaan Kajian Pencapaian PEO, Objektif Pendidikan Program (PEO) adalah salah satu kriteria penilaian jangka panjang suatu program pengajian yang menyokong visi, misi dan matlamat keseluruhan pendidikan sesebuah institusi. Elemen penilaian ini juga melibatkan beberapa proses yang perlu dilaksanakan dalam pembangunan dan penambahbaikan kurikulum antaranya ialah semakan semula bagi PEO sedia ada, penggubalan dan pengesahan pernyataan PEO yang baharu dan penilaian PEO yang dibuat setelah 3 hingga 5 tahun pelajar bergraduat.

Pernyataan PEO bagi setiap program pengajian merupakan proses pembangunan dan penambahbaikan kurikulum bagi graduan yang telah bergraduat dalam tempoh 3 hingga 5 tahun di mana penggubalannya mewakili kriteria graduan yang dihasratkan oleh kurikulum itu sendiri. Justeru, satu kajian telah dilakukan bagi melengkapkan keberkesanan PEO ini dalam mengenalpasti prestasi graduan dan PEO program Diploma Kejuruteraan Awam (DKA) di Politeknik Kota Kinabalu yang menggunapakai kurikulum DKA Versi 2014 menerusi analisis dari data-data yang dikumpulkan daripada graduan dan majikan. Empat (4) PEO yang digariskan adalah seperti yang ditunjukkan dalam Jadual 1.

Jadual 1. PEO Program Diploma Kejuruteraan Awam bagi Kurikulum Versi 2014

Objektif Pendidikan Program (PEO)	Butiran
PEO 1	Mengintegrasikan prinsip kejuruteraan awam dan membangunkan pemikiran kritikal untuk menyelesaikan masalah dalam kerja rekabentuk dan cekap secara teknikal dalam bidang kejuruteraan
PEO 2	Memaparkan kemahiran praktikal dan berkomunikasi secara berkesan dalam persekitaran kerja global
PEO 3	Mempunyai pembelajaran sepanjang hayat, tanggungjawab sosial dan keusahawanan
PEO 4	Membina kemahiran kepimpinan dan kerja berpasukan, ketinggian yang betul dan etika professional

Kajian ini dijalankan secara dalaman terhadap graduan DKA di mana ia bertujuan untuk menilai pencapaian PEO bagi program DKA dalam penghasilan graduan yang mempunyai tenaga kerja yang berpengetahuan dan berkemahiran, amalan sikap positif kendiri dan berkumpulan dalam kumpulan kepimpinan serta sikap keusahawanan graduan DKA.

2.0 PENYATAAN MASALAH

Pencapaian PEO dalam setiap program di institusi pengajian tinggi merupakan satu keperluan yang amat penting. Kepelbagaian aspek di dalam istilah kepentingan ini meliputi keperluan pembelajaran yang telah ditetapkan oleh *Engineering Technology Accreditation Council* (ETAC) dan Agensi Kelayakan Malaysia (MQA). Justeru, satu kajian perlu dilaksanakan daripada sudut pandangan graduan dan majikan bagi melihat keberkesanan pencapaian PEO ini. Kajian ini merupakan salah satu pendekatan penilaian terhadap PEO menerusi pengumpulan data bagi program pengajian Diploma Kejuruteraan Awam (DKA)

yang ditawarkan di Politeknik Kota Kinabalu (PKK) di mana ia menggunapakai Veri kurikulum DKA 2014.

3.0 OBJEKTIF KAJIAN

Kajian ini dilaksanakan adalah untuk mengenalpasti dan menganalisa tahap keberkesanan dan pencapaian Objektif Program Pengajian (PEO) program Diploma Kejuruteraan Awam (DKA) bagi kurikulum DKA Versi 2014 di kalangan graduan program DKA dan majikan.

4.0 KEPENTINGAN KAJIAN

Kajian ini memainkan peranan penting untuk mengenalpasti dan menganalisis tahap pencapaian Objektif Program Pengajian (PEO) bagi Program Diploma Kejuruteraan Awam (DKA) di kalangan para graduan DKA. Program ini telah menggariskan empat (4) PEO iaitu PEO 1, PEO 2, PEO 3 dan PEO 4. Kajian ini penting dalam memastikan sasaran penetapan objektif mencapai tahap peratusan yang telah ditetapkan oleh keputusan mesyuarat yang melibatkan pihak JPPKK dan industri iaitu sebanyak 50%. Hasil kajian ini juga mampu membantu dalam menambahbaik kurikulum yang sedia ada bagi pencapaian objektif yang lebih baik seiring dengan penghasilan tenaga kerja dan usahawan yang berpengetahuan dan berkemahiran terhadap graduan DKA.

5.0 SKOP KAJIAN

Kajian ini mengarah kepada para graduan bagi sesi pengajian Jun 2014 sehingga Jun 2017 yang mengambil jurusan program Diploma Kejuruteraan Awam (DKA), Politeknik Kota Kinabalu. Para graduan ini telah melengkapkan proses pelaksanaan kurikulum DKA Versi 2014. Maklumbalas telah diberikan oleh seramai 450 orang graduan DKA daripada 750 orang yang tamat pengajian pada sesi tersebut dan kerjasama yang baik telah diberikan terhadap pengedaran soal selidik secara dalam talian menggunakan kaedah *Google Form*. Instrumen dan soalan yang digunapakai adalah berdasarkan kepada instrument lama yang telah dibangunkan oleh pihak JPPKK.

6.0 KAJIAN LITERATUR

Merujuk kepada Manual Pembangunan Kurikulum Politeknik (2013), kurikulum ditafsirkan sebagai proses pengalaman dan hasil pembelajaran yang dirancang melalui pembentukan semula pengetahuan dan pengalaman secara sistematik di bawah pengawasan institusi dan berpacukan industri untuk perkembangan kompetensi pelajar yang berterusan. Kurikulum juga bermaksud suatu perancangan pendidikan yang mengandungi segala ilmu pengetahuan, tahap kemahiran, nilai serta unsur-unsur kebudayaan yang menjadi pilihan masyarakat untuk diwariskan daripada generasi kepada satu generasi yang lain (Sudiarwadi, n.d).

Kebanyakan kurikulum bagi suatu program pengajian di politeknik adalah berdasarkan pendekatan berkaitan Pembelajaran Berasaskan Hasil (OBE) di mana pendekatan ini merangkumi beberapa kriteria seperti pencapaian PEO, PLO dan CLO. Selain daripada itu, kepelbagaian kriteria ini juga harus mematuhi garis panduan standard program diploma dan Kerangka Kelayakan Malaysia. Sistem pembelajaran masa kini yang berdasarkan kepada pembelajaran berpusatkan pelajar (OBE) amat digalakkan kerana dapat memaksimumkan

penglibatan pelajar di bilik kuliah (Wan Othman W. M. T, 2018). Hal ini mampu memberikan impak dalam menghubungkaitkan pencapaian graduan seiring dengan keperluan bagi pencapaian PEO, PLO serta CLO dalam sesuatu kurikulum.

Menurut Rahman et al. (2018), Objektif Pendidikan Program (PEO) ditakrifkan sebagai penyataan matlamat secara khusus untuk mewakili pencapaian yang diharapkan kepada graduan setelah beberapa tahun selepas merek menamatkan pengajian. Selain itu, Ab-Rahman et al. (2022) pula menyatakan bahawa PEO membentuk beberapa kriteria yang memerlukan penilaian bagi memastikan keberterusannya selaras dengan visi, misi dan pencapaian sesebuah institusi. Penyataan bagi Abbadeni et al. (2013) pula mentakrifkan elemen tersebut sebagai satu elemen menyeluruh yang memperjelaskan pencapaian oleh graduan bagi kebanyakan program tertentu yang perlu dicapai setelah menamatkan tempoh pengajian mereka. PEO juga mampu diperjelaskan melalui jangkaan pencapaian graduan di dalam aspek kerjaya dan profesionalisme mereka selepas menamatkan pengajian (Pramono et al., 2022). Beberapa kajian terdahulu turut menjelaskan PEO dalam konteks bidang kejuruteraan (Abbadeni et al., 2013; Jayaprakash, 2025; Sundaram, 2018). Sebagai contoh, PEO bagi program Sarjana Muda di dalam kejuruteraan mewujudkan visi program mereka untuk graduannya dalam tempoh tiga hingga lima tahun selepas tempo tamat pengajian. Pentakrifan pencapaian PEO bagi sesuatu program ijazah kejuruteraan adalah penyataan yang memperjelaskan perkara yang diinginkan untuk dilaksana dan dicapai oleh graduan dalam tempoh beberapa tahun pertama selepas tamat pengajian mereka (Jayaprakash, 2025). Di Malaysia, PEO yang telah digariskan ialah penyataan secara meluas yang menggambarkan jangkaan pencapaian oleh graduan dalam tempoh tiga hingga lima tahun setelah graduan menamatkan tempoh pengajian di sesuatu institusi. Menurut Hairi et al. (2019), Semua program di dalam institusi di Malaysia perlu mengukur PEO.

PEO juga telah banyak dilaksanakan dalam ruang lingkup di dalam dan juga di luar negara seperti di India (Jayaprakash, 2025; Sundaram, 2018), di Filipina (German et al., 2021), dan di Malaysia (Ab-Rahman et al., 2022; Hairi et al., 2019; Makinda et al., 2016; Rahman et al., 2018). Dalam konteks politeknik di Malaysia, Hairi et al. (2019) pula menjelaskan bahawa PEO bagi politeknik perlu diukur selepas lima tahun pelaksanaan sesuatu program. Perkara ini menunjukkan bahawa pengukuran PEO memerlukan perhatian yang mendalam untuk ditlaksanakan terutama melibatkan program yang mempunyai kepelbagaian jenis bidang. Analisa kajian juga memperlihatkan bahawa kajian PEO lebih banyak diberi fokus kepada bidang kejuruteraan dan teknikal sahaja (Ab-Rahman et al., 2022; German et al., 2021; Rahman et al., 2018).

7.0 METODOLOGI KAJIAN

Kaedah secara tinjuan dilakukan di dalam perlaksanaan kajian ini dengan menggunakan instrumen borang soal selidik (Mohd Najib Ghafar, 1999; Matore *et al*., 2021). Kajian penilaian ini telah dilakukan terhadap 750 orang graduan yang terdiri daripada graduan DKA bagi Sesi Jun 2014 sehingga Jun 2017 namun hanya 450 orang responden telah memberi maklumbalas (Creswell, 2018). Instrumen dan soalan yang digunapakai adalah berdasarkan kepada instrument lama. Terdapat dua (2) bahagian penilaian yang telah digariskan mengikut ketetapan format yang diterjemahkan ke dalam *Google Form* bagi memudahkan penyebaran instrumen kepada para graduan. Bahagian A untuk demografi graduan yang mengandungi sebelas (11) soalan dan Bahagian B bagi maklumbalas graduan politeknik berdasarkan setiap PEO yang dinayatakan sebanyak sembilan (9) soalan.

Instrumen kajian ini menggunakan Skala Likert yang membahagikan kepada lima tahap pilihan iaitu Sangat Lemah (1), Lemah (2), Sederhana (3), Baik (4) dan Sangat Baik (5). Penetapan sasaran yang telah dipersetujui hasil daripada mesyuarat bagi pencapaian kesemua PEO program Diploma Kejuruteraan Awam (DKA) adalah sebanyak 50 peratus. Keseluruhan data yang diperolehi telah dianalisis dan diterjemahkan dalam bentuk jadual, carta dan juga nilai peratusan bagi setiap PEO.

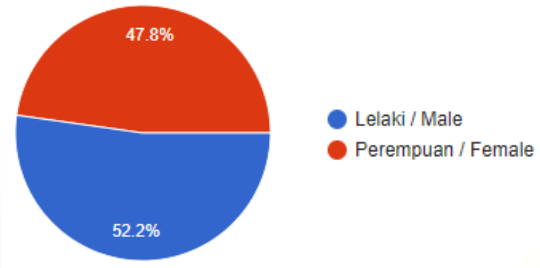


Rajah 1: Carta alir kajian

Kajian ini juga menggunapakai instrumen yang telah melalui proses pengesahan terhadap kandungan kajian oleh pakar dalam bidang yang dimiliki termasuk dari pihak industri sebelum diedarkan kepada responden. Panel yang telah dilantik telah menyemak dan memberi pandangan serta cadangan terhadap format, kandungan dan struktur gaya bahasa di dalam soal selidik. Kepelbagaian kriteria juga telah diambil kira dan digunapakai bagi menambahbaik maksud, bahasa dan kandungan soal selidik yang dibangunkan.

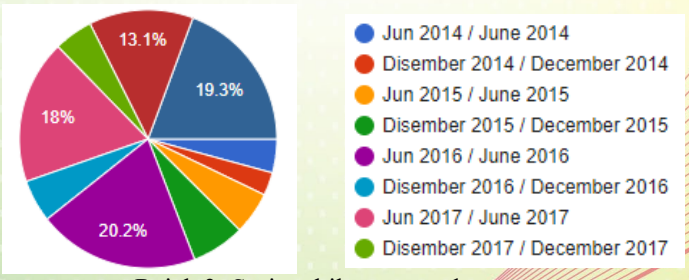
8.0 DAPATAN DAN PERBINCANGAN

BAHAGIAN A: MAKLUMAT DEMOGRAFI DAN PENJAWATAN



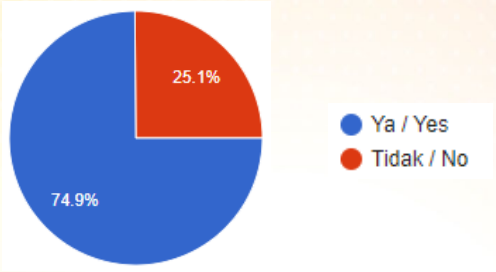
Rajah 2: Jantina responden

Responden kajian terdiri daripada 52.2 peratus lelaki dan bakinya iaitu sebanyak 47.8 peratus merupakan responden perempuan.



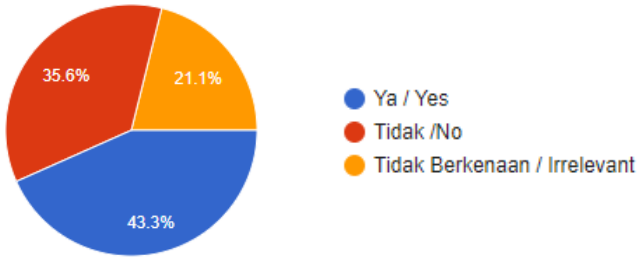
Rajah 3: Sesi ambilan responden

Merujuk carta pai di dalam Rajah 3, ia menunjukkan maklumat mengenai sesi ambilan responden bagi kajian. Majoriti responden yang memberi maklumbalas mengikut nilai tertinggi adalah sebanyak 20.2 peratus berada pada sesi Jun 2016, 19.3 peratus pada sesi Jun 2014, 18 peratus pada sesi Jun 2017, 13.1 peratus pada sesi Disember 2014 dan lain-lain adalah pada sesi Jun 2015, sesi Disember 2015, sesi Disember 2016 dan sesi Disember 2017.



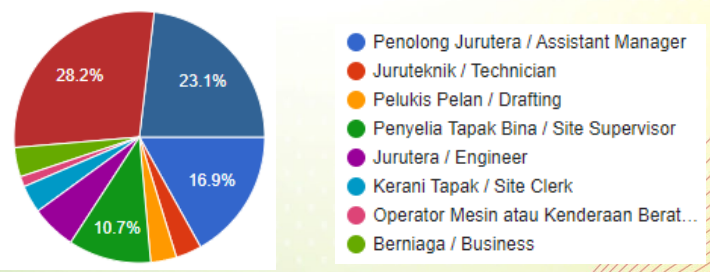
Rajah 4: Status pekerjaan responden

Carta seperti di dalam Rajah 4 menunjukkan data bagi status pekerjaan responden. Majoriti responden iaitu sebanyak 74.9 peratus (333 orang responden) merupakan mereka yang telah mendapat pekerjaan manakala 25.1 peratus responden merupakan mereka yang tidak bekerja atau menyambung pengajian di institusi masing-masing.



Rajah 5: Pekerjaan mengikut bidang

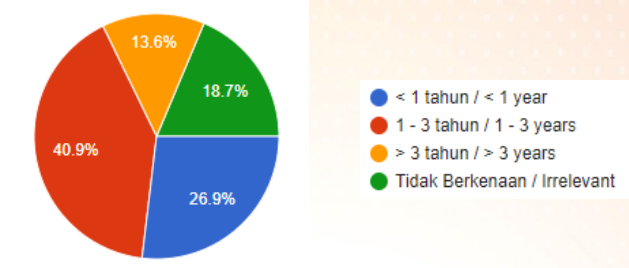
Rajah 5 menunjukkan pengkhususan bidang dalam pekerjaan bagi responden. Majoriti responden iaitu sebanyak 43.3 peratus bekerja di dalam bidang pengkhususan seperti Penolong Jurutera, Penyelia Tapak dan sebagainya. Sejumlah 35.6 peratus responden tidak berada di dalam bidang pengkhususan seperti bergiat dalam bidang keusahawanan dan didapati 21.1 peratus responden menyambung pengajian atau tidak bekerja.



Rajah 6: Jawatan responden

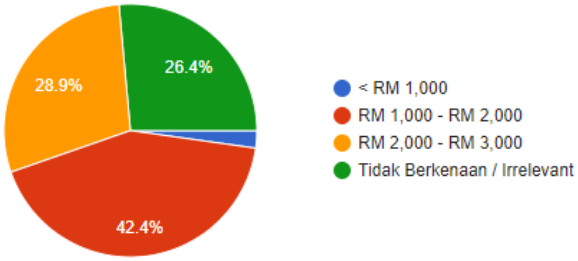
Berdasarkan carta di dalam Rajah 6, kebanyakan graduan berada di dalam jawatan masing-masing sebagai Juruteknik dan Penolong Jurutera iaitu sebanyak 28.2 peratus dan 23.1 peratus.

Sejumlah 10.7 peratus graduan pula dilantik sebagai Penyelia Tapak Bina dan 16.9 peratus berada di dalam jawatan sebagai Kerani Tapak. Ini menunjukkan majoriti penjawatan graduan adalah selari dengan kurikulum yang digunapakai bagi prospek pekerjaan.



Rajah 7: Pengalaman bekerja

Rajah 7 menunjukkan pengalaman bekerja responden setelah bergraduat mengikut sesi pengajian masing-masing. Responden yang mempunyai pengalaman kerja 1 hingga 3 tahun memberi nilai paling ramai iaitu sebanyak 40.9 peratus. Sebanyak 26.9 peratus pula mempunyai pengalaman kurang dari setahun. Ini disebabkan oleh kebanyakkan graduan DKA bagi sesi Jun dan Disember 2017 baru sahaja 3 tahun lebih bergraduat. Sejumlah 13.6 peratus pula mempunyai pengalaman bekerja lebih dari 3 tahun manakala selebihnya memberi nilai sebanyak 18.7 peratus di mana responden adalah tidak bekerja atau menyambung pengajian.



Rajah 8: Gaji

Nilai terbesar dalam Rajah 8 memberi nilai yang tinggi bagi pendapatan di antara RM1000-RM2000 iaitu sebanyak 42.4 peratus. Ini diikuti pula dengan gaji sebanyak RM2000-RM3000 iaitu sebanyak 28.9 peratus dan yang tidak berkenaan adalah 26.4 peratus daripada responden. Perbezaan nilai gaji dan responden ini bergantung kepada penjawatan kerja oleh responden.

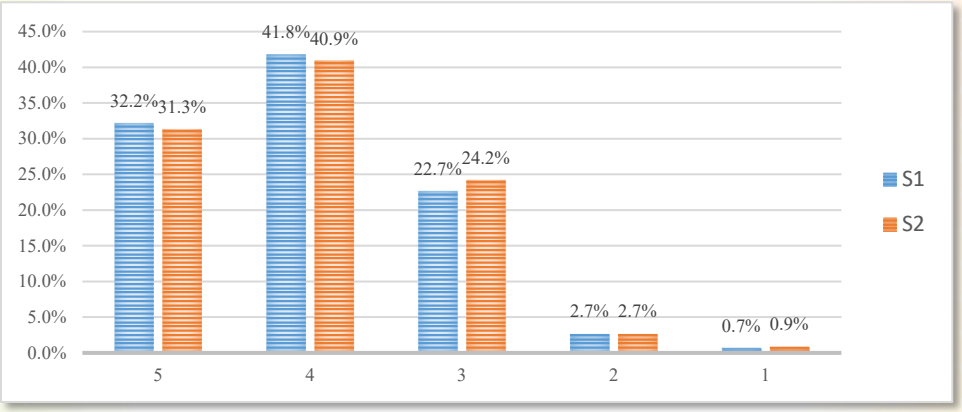
BAHAGIAN B: PENCAPAIAN PEO PROGRAM

Perbincangan terhadap dapatan serta data yang telah diperolehi hasil daripada maklum balas responden yang telah menjawab soalan-soalan kajian berdasarkan setiap PEO yang dinyatakan iaitu sebanyak sembilan (9) soalan di dalam bahagian ini. Analisa terhadap data adalah lebih bertumpu kepada skor positif iaitu Sangat Baik (Skor 5) dan Baik (skor 4).

Jadual 2. Pencapaian PEO program bagi PEO 1

PEO 1 – *Mengintegrasikan prinsip kejuruteraan awam dan membangunkan pemikiran kritikal untuk menyelesaikan masalah dalam kerja rekabentuk dan cekap secara teknikal dalam bidang kejuruteraan*								
Item	**Item Soalan**	**Skor (%)**					**Purata Skor (%)**	**Tahap Interpretasi Min**
		5	**4**	**3**	**2**	**1**		
S1	Berpengetahuan dalam bidang yang dipelajari bersesuaian dengan keperluan industri	145	188	102	12	3	74.0	4.02 Tinggi
		32.2	41.8	22.7	2.7	0.7		
S2	Mampu dalam menyelesaikan masalah yang melibatkan kemahiran dalam bidang yang dipelajari	141	184	109	12	4	72.2	3.99 Tinggi
		31.3	40.9	24.2	2.7	0.9		

Secara keseluruhannya, pencapaian bagi PEO 1 mencapai tahap yang tinggi iaitu purata skor sebanyak 72.2% sehingga 74.0%. Dapatan menunjukkan graduan DKA bersetuju Program DKA politeknik dapat melahirkan graduan atau pekerja yang berpengetahuan dan mampu mengintegrasi prinsip kejuruteraan awam serta mewujudkan pemikiran kritikal terhadap penyelesaian masalah yang cekap dalam kerja-kerja teknikal di dalam bidang kejuruteraan.



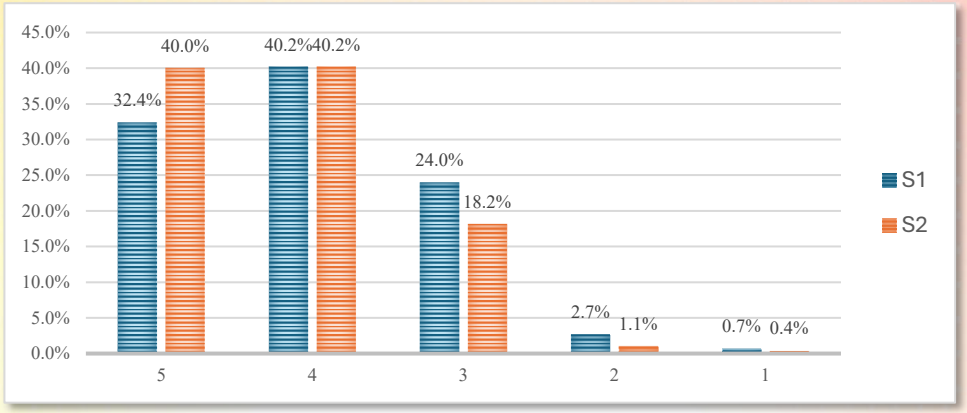
Rajah 9: Analisa PEO1

Jadual 3. Pencapaian PEO program bagi PEO 2

PEO 2 – *Memaparkan kemahiran praktikal dan berkomunikasi secara berkesan dalam persekitaran kerja global*								
Item	**Item Soalan**	**Skor (%)**					**Purata Skor (%)**	**Tahap Interpretasi Min**
		5	**4**	**3**	**2**	**1**		
S1	Berkemahiran dalam bidang yang dipelajari bersesuaian dengan keperluan industri	146	181	108	12	3	72.7	4.01 Tinggi
		32.4	40.2	24.0	2.7	0.7		
S2	Berkomunikasi dengan berkesan di persekitaran perindustrian	180	181	82	5	2	80.2	4.18 Tinggi
		40.0	40.2	18.2	1.1	0.4		

Pencapaian PEO 2 adalah mencapai tahap yang tinggi iaitu peratus skor sebanyak 72.7% hingga 80.2%. Dapatan menunjukkan graduan PKK bersetuju Program DKA politeknik berjaya melahirkan pekerja yang dapat memperlihatkan kemahiran praktikal dan komunikasi secara berkesan dalam persekitaran kerja yang luas. Graduan juga mempunyai kemahiran

mengendalikan dan menerangkan penggunaan peralatan kejuruteraan ketika melaksanakan tugasan yang diberikan oleh majikan.

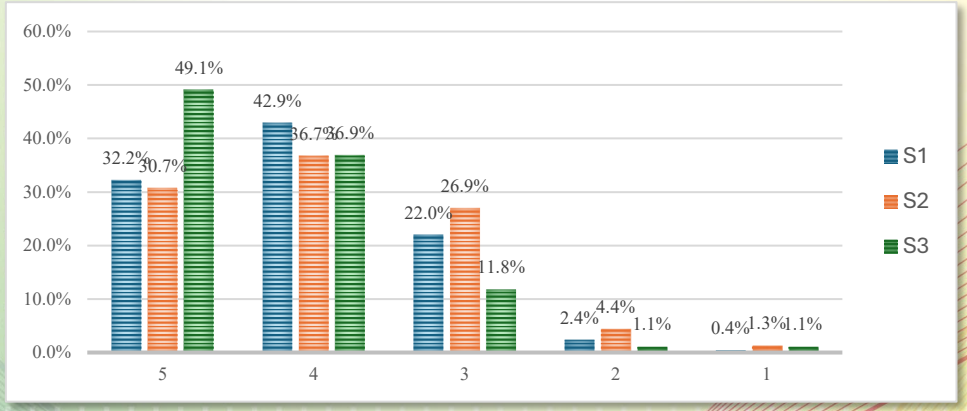


Rajah 10: Analisa PEO2

Jadual 4. Pencapaian PEO program bagi PEO 3

PEO 3 – *Mempunyai pembelajaran sepanjang hayat, tanggungjawab sosial dan keusahawanan*								
Item	**Item Soalan**	**Skor (%)**					**Purata Skor (%)**	**Tahap Interpretasi Min**
		5	**4**	**3**	**2**	**1**		
S1	Peka dalam menyelesaikan masalah yang melibatkan kemahiran dalam bidang yang dipelajari	145	193	99	11	2	75.1	4.04 Tinggi
		32.2	42.9	22.0	2.4	0.4		
S2	Mengaplikasikan kemahiran keusahawanan di dalam alam pekerjaan dalam alam pekerjaan	138	165	121	20	6	67.3	3.9 Tinggi
		30.7	36.7	26.9	4.4	1.3		
S3	Bersedia untuk menerima kursus lanjutan untuk meningkatkan pengetahuan (pembelajaran sepanjang hayat)	221	166	53	5	5	86.0	4.32 Tinggi
		49.1	36.9	11.8	1.1	1.1		

Pencapaian PEO 3 memperolehi capaian tahap yang tinggi iaitu skor peratus sebanyak 67.3% sehingga 86.0%. Dapatan menunjukkan graduan PKK bersetuju Program DKA politeknik dapat melahirkan graduan yang mampu berdaya saing dalam bidang keusahawanan dan perniagaan. Graduan juga bersedia mengambil inisiatif untuk meningkatkan pengetahuan dan kemahiran menerusi kursus-kursus tambahan selari dengan bidang yang diceburi.

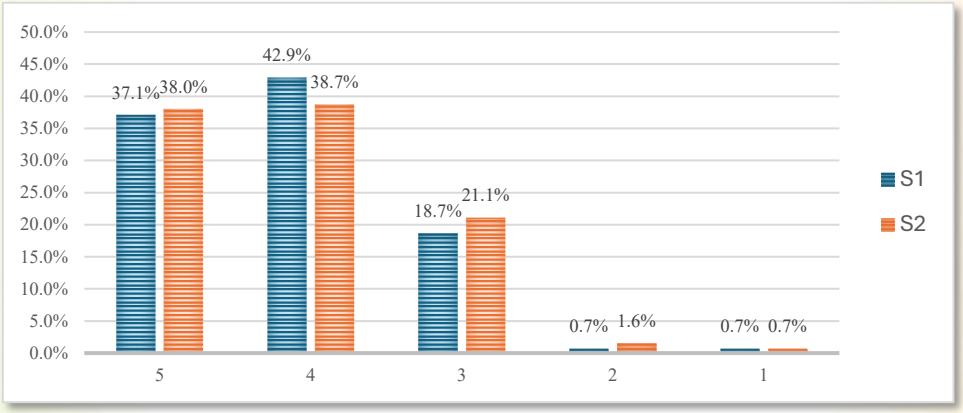


Rajah 11: Analisa PEO3

Jadual 5. Pencapaian PEO program bagi PEO 4

PEO 4 – *Membina kemahiran kepimpinan dan kerja berpasukan, ketinggian yang betul dan etika professional*								
Item	**Item Soalan**	**Skor (%)**					**Purata Skor (%)**	**Tahap Interpretasi Min**
		5	**4**	**3**	**2**	**1**		
S1	Beretika dalam menyelesaikan masalah yang melibatkan kemahiran dalam bidang yang dipelajari	167	193	84	3	3	80.0	4.15 Tinggi
		37.1	42.9	18.7	0.7	0.7		
S2	Memimpin dalam kerja yang bercirikan pasukan di persekitaran perindustrian	171	174	95	7	3	76.7	4.12 Tinggi
		38.0	38.7	21.1	1.6	0.7		

Secara keseluruhannya, pencapaian PEO 4 juga mencapai tahap yang tinggi iaitu skor peratus sebanyak 76.7% sehingga 80.0%. Dapatan menunjukkan graduan PKK bersetuju Program DKA politeknik berjaya melahirkan graduan yang berkebolehan mengetuai sesuatu kumpulan di tempat kerja untuk melaksanakan tugasan yang diberikan. Graduan juga dapat melahirkan sikap dan etika professional seperti tingkahlaku yang baik, berdisiplin dan memberi arahan yang tersusun di dalam kumpulan kerja.



Rajah 12: Analisa PEO 4

9.0 RUMUSAN

Berikut merupakan jadual rumusan keseluruhan bagi analisis yang telah dilakukan terhadap Penilaian Objektif Pendidikan Program (PEO) bagi semua graduan Sesi Jun 2014 sehingga Sesi Jun 2017 bagi program DKA di Politeknik Kota Kinabalu.

Jadual 6. Rumusan Keseluruhan Analisis PEO

Analisis Soalan Soal Selidik		**Analisis PEO**	
Soalan	**Peratus Skor (Skor 4 dan 5) (%)**	**PEO**	**Skor Min**
S1	74.0	PEO1	4.02
S2	72.2		3.99
S1	72.7	PEO2	4.01
S2	80.2		4.18
S1	75.1	PEO3	4.04
S2	67.3		3.91
S3	86.0		4.32
S1	80.0	PEO4	4.15
S2	76.7		4.12

Kebanyakan responden juga turut memberi maklum balas terhadap cadangan penambahbaikan secara langsung atau tidak langsung terhadap penambahbaikan kurikulum iaitu 1) program dapat memberi pendedahan awal berkaitan kerja-kerja asas pembinaan, 2) pendedahan dan penambahan kemahiran dalam penggunaan peralatan dan mesin selari dengan keperluan industri, 3) menambah peralatan yang lebih canggih, terkini dan pelbagai guna di bengkel-bengkel, memperbanyakkan lawatan ke industri dan 4) memperbanyakkan program serta kursus yang berkaitan peluang kerjaya dalam bidang DKA.

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MENEROKA LITERASI HIJAU DALAM KALANGAN PELAJAR KOLEJ KOMUNITI: SATU KAJIAN KES DI KOLEJ KOMUNITI SEBERANG JAYA

B. Chitthra a/p Balakrishnan[1*], Saiful Anuar bin Mohamad [2], Najmi Hawa binti Abdul Wahab[3]

[12] Unit Teknologi Elektrik Kolej Komuniti Seberang Jaya,
[3]Unit Teknologi Maklumat
13700 Permatang Pauh, Pulau Pinang

*cthra125@gmail.com

Abstrak

Kelestarian alam sekitar semakin menjadi agenda penting dalam pembangunan global, terutamanya dalam konteks Pendidikan dan Latihan Teknikal dan Vokasional (TVET). Kajian ini dijalankan bagi meneroka tahap literasi hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya (KKSJ) dari aspek pengetahuan dan amalan, serta menilai hubungan antara kedua-dua elemen tersebut. Kajian berbentuk kuantitatif deskriptif ini melibatkan 127 orang pelajar dan menggunakan soal selidik sebagai instrumen utama pengumpulan data. Analisis statistik menunjukkan tahap pengetahuan pelajar berada pada tahap tinggi dengan purata skor min 3.79, manakala tahap amalan kelestarian pula mencatatkan skor min 3.77. Dapatan juga menunjukkan korelasi Pearson yang sangat kuat dan signifikan antara pengetahuan dan amalan ($r = 0.917$, $p < 0.01$), sekali gus mengesahkan bahawa peningkatan literasi hijau berupaya mempengaruhi tindakan lestari dalam kalangan pelajar. Namun, beberapa aspek amalan hijau seperti pengurangan penggunaan plastik dan pengurusan sisa secara sistematik masih menunjukkan tahap sederhana. Ini menunjukkan bahawa walaupun kesedaran dan pengetahuan tentang kelestarian tinggi, tindakan sebenar masih bergantung kepada motivasi intrinsik dan kemudahan kemudahan yang disediakan. Kajian ini mencadangkan agar pendidikan hijau diintegrasikan secara sistematik dalam kurikulum TVET melalui pendekatan pembelajaran berasaskan projek (PBL), kerjasama industri, dan penglibatan komuniti hijau. Hasil kajian ini menyokong pencapaian Matlamat Pembangunan Mampan (SDG 4, SDG 11, SDG 13) melalui transformasi pendidikan TVET ke arah kampus hijau yang lebih holistik dan berimpak tinggi.

***Kata kunci**: Literasi Hijau, TVET Hijau, Amalan Lestari, Kolej Komuniti, SDG.*

Abstract

Environmental sustainability has become a critical agenda in global development, particularly within the context of Technical and Vocational Education and Training (TVET). This study aims to explore the level of green literacy among students at Kolej Komuniti Seberang Jaya (KKSJ) in terms of knowledge and practices, as well as to assess the relationship between these two components. This quantitative descriptive study involved 127 students and utilized a structured questionnaire as the primary data collection instrument. Statistical analysis revealed that the level of environmental knowledge among students was high, with a mean score of 3.79, while the level of sustainable practices recorded a mean score of 3.77. The findings also indicated a very strong and statistically significant Pearson correlation between knowledge and practices ($r = 0.917$, $p < 0.01$), confirming that increased green literacy has the potential to influence sustainable actions among students. However, certain sustainable practices, such as reducing plastic use and systematic waste management, remained at a moderate level. This suggests that despite high awareness and knowledge of sustainability, actual practice is still contingent upon intrinsic motivation and the availability of supporting facilities. The study recommends the systematic integration of green education into the TVET curriculum through project-based learning (PBL), industrial partnerships, and green community engagement. The findings of this study align with the achievement of the Sustainable Development Goals (SDG 4, SDG 11, SDG 13) by transforming TVET education towards a more holistic and impactful green campus approach.

***Keywords:** Green Literacy, Green TVET, Sustainable Practices, Community College, SDG.*

1. Pengenalan

Isu kelestarian alam sekitar kini menjadi perhatian global apabila dunia berhadapan dengan cabaran seperti perubahan iklim, pelepasan karbon berlebihan, pencemaran, dan penyusutan sumber asli. Situasi ini memerlukan pendekatan kolektif dan transformasi menyeluruh dalam semua sektor, termasuk pendidikan dan latihan. Dalam hal ini, institusi Pendidikan dan Latihan Teknikal dan Vokasional (TVET) berperanan penting dalam melahirkan tenaga kerja yang bukan sahaja berkemahiran teknikal, malah turut mempunyai kesedaran dan tanggungjawab terhadap pemeliharaan alam sekitar (Salleh et al., 2021). Pendidikan TVET perlu melangkaui penguasaan teknikal semata-mata dengan mengintegrasikan elemen kelestarian bagi melahirkan graduan yang berdaya tahan dan beretika dalam mendepani cabaran abad ke-21. TVET kini diiktiraf bukan sahaja sebagai laluan kerjaya, tetapi juga sebagai platform penting untuk mempromosikan pembangunan mampan. Konsep TVET Hijau (Green TVET) telah diperkenalkan sebagai pendekatan untuk mengintegrasikan kemahiran teknikal dengan nilai-nilai kelestarian dan kesedaran alam sekitar. Konsep literasi hijau menjadi semakin penting dalam kerangka ini, merangkumi pengetahuan, kesedaran, sikap dan amalan individu terhadap prinsip kelestarian dan teknologi hijau. Literasi hijau bukan sekadar pemahaman terhadap isu alam sekitar, tetapi juga keupayaan untuk bertindak dan membuat keputusan yang lestari dalam kehidupan seharian dan dunia pekerjaan (Md Nor, 2022). Seiring dengan komitmen Malaysia terhadap Matlamat Pembangunan Mampan (Sustainable Development Goals – SDG), pelbagai dasar dan pelan tindakan telah diperkenalkan seperti Dasar Teknologi Hijau Negara, Dasar Alam Sekitar Negara, dan Pelan Strategik TVET Malaysia 2022–2030. Antara SDG yang berkait rapat dengan agenda ini ialah SDG 4 (Pendidikan Berkualiti), SDG 11 (Bandar dan Komuniti Lestari) dan SDG 13 (Tindakan Terhadap Perubahan Iklim). Namun begitu, pelaksanaan pendidikan berteraskan kelestarian di peringkat institusi TVET masih menghadapi cabaran dari segi integrasi kurikulum, penglibatan pelajar, serta penilaian impak.

1.1 Latarbelakang Kajian

Kolej Komuniti Seberang Jaya (KKSJ) sebagai salah sebuah institusi TVET di bawah JPPKK menyambut baik dasar ini dengan memberi fokus kepada penerapan nilai kelestarian dalam kalangan pelajar. Usaha ini penting bagi memastikan pelajar bukan sahaja bersedia untuk menyertai tenaga kerja, tetapi juga mempunyai kesedaran tinggi terhadap isu alam sekitar dan peranan mereka dalam menyokong pembangunan mampan. Namun begitu, pemerhatian awal menunjukkan bahawa keberkesanan pelaksanaan pendidikan hijau di institusi ini masih belum dapat diukur secara empirikal. Tahap kesedaran, pengetahuan, dan penglibatan pelajar terhadap teknologi hijau serta amalan kelestarian harian masih belum dipetakan secara sistematik. Tambahan pula, kajian literatur menunjukkan bahawa masih terdapat jurang antara pengetahuan teori dan pengamalan praktikal dalam kalangan pelajar institusi TVET berkaitan isu kelestarian (Khairul et al., 2020; Noraini & Latifah, 2021). Sehubungan itu, kajian ini dijalankan untuk meneroka secara terperinci tahap literasi hijau dalam kalangan pelajar KKSJ, merangkumi aspek pengetahuan, kesedaran dan penglibatan. Kajian ini bukan sahaja bertujuan menyokong agenda TVET Hijau di peringkat institusi, malah menjadi bukti sokongan terhadap hala tuju dasar negara dan komitmen global terhadap pembangunan mampan menjelang 2030.

1.2 Pernyataan Masalah

Krisis alam sekitar global seperti perubahan iklim, pencemaran sumber asli, dan kemerosotan biodiversiti menuntut perubahan sistemik dalam pelbagai sektor, termasuk

pendidikan. Dalam konteks Pendidikan dan Latihan Teknikal dan Vokasional (TVET), keperluan untuk melahirkan graduan yang bukan sahaja berkemahiran teknikal tetapi juga berkesedaran alam sekitar adalah semakin mendesak. Konsep literasi hijau yang merangkumi pengetahuan, kesedaran dan amalan berkaitan kelestarian kini menjadi asas penting dalam pembentukan modal insan lestari. Namun begitu, kajian-kajian terdahulu menunjukkan bahawa pelaksanaan pendidikan kelestarian di institusi TVET masih belum menyeluruh. Noraini dan Latifah (2021) menyatakan bahawa integrasi pendidikan alam sekitar dalam kurikulum TVET masih bersifat terpisah dan tidak sistematik. Sementara itu, Khairul et al. (2020) mendapati bahawa tahap kesedaran pelajar terhadap isu kelestarian berada pada tahap sederhana dan bergantung kepada inisiatif pensyarah atau institusi. Jurang yang wujud antara pengetahuan, kesedaran dan tindakan ini boleh menjejaskan matlamat pembentukan graduan yang holistik dan bertanggungjawab terhadap alam sekitar. Situasi ini juga memberi implikasi terhadap pencapaian Matlamat Pembangunan Mampan (SDG), khususnya SDG 4 (Pendidikan Berkualiti), SDG 11 (Bandar dan Komuniti Lestari), dan SDG 13 (Tindakan Terhadap Perubahan Iklim). Tanpa pelaksanaan pendidikan hijau yang menyeluruh dan terarah, peranan institusi TVET dalam menyumbang kepada pembangunan mampan akan terus terbatas. Oleh itu, kajian ini dijalankan bagi menilai tahap literasi hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya secara empirikal, serta mencadangkan langkah strategik ke arah pengukuhan agenda TVET Hijau.

1.3 Objektif Kajian

Secara khususnya, kajian ini telah dijalankan untuk:

1.3.1 Mengenal pasti tahap pengetahuan tentang kelestaraian hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya.
1.3.2 Meninjau tahap amalan pelajar Kolej Komuniti Seberang Jaya terhadap kelestarian hijau.
1.3.3 Mengukur korelasi/hubungan pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya.

1.4 Hipotesis Kajian

H1: Terdapat hubungan yang signifikan antara pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya.

H0: Tidak terdapat hubungan yang signifikan antara pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya.

1.5 Kepentingan Kajian

Kajian ini memberi sumbangan yang signifikan kepada pelbagai pihak dan bidang, khususnya dalam konteks pendidikan TVET, dasar pembangunan mampan, dan pembentukan modal insan celik kelestarian. Antara kepentingan utama kajian ini ialah:

1.5.1 Menyokong Agenda Pembangunan Mampan (SDG)

Kajian ini sejajar dengan Matlamat Pembangunan Mampan (SDG), khususnya:

- SDG 4 – Pendidikan Berkualiti: Kajian ini menyumbang kepada pengukuhan kurikulum TVET yang mengintegrasikan pendidikan hijau sebagai elemen penting dalam membentuk pelajar yang bukan sahaja berkemahiran teknikal, tetapi juga celik alam sekitar.

- SDG 11 – Bandar dan Komuniti Lestari: Melalui pembudayaan amalan hijau dalam kalangan pelajar, institusi TVET dapat melahirkan graduan yang mampu menjadi agen perubahan dalam komuniti mereka.

- SDG 13 – Tindakan Terhadap Perubahan Iklim: Dengan meningkatkan kesedaran dan pengetahuan pelajar terhadap isu perubahan iklim, kajian ini menyumbang kepada pembangunan masyarakat yang lebih proaktif dalam tindakan mitigasi dan adaptasi iklim.

1.5.2 Menyokong Bidang Tumpuan Politeknik dan Kolej Komuniti

Kajian ini selaras dengan Bidang Keutamaan JPPKK seperti:

- TVET Hijau: Kajian ini menjadi asas kepada strategi membangunkan program TVET yang mampan dan mesra alam.

- Kelestarian Institusi Pendidikan: Dapatan kajian ini mampu memacu pembentukan polisi dalaman kolej berkaitan pengurusan hijau, aktiviti lestari, serta penilaian impak program hijau pelajar.

- Pengantarabangsaan dan Penyelidikan: Kajian ini menyediakan data empirik yang boleh dikembangkan sebagai asas kepada penerbitan jurnal atau pembentangan di forum antarabangsa.

1.5.3 Membantu Penggubal Dasar dan Pengurusan Institusi

Maklumat daripada kajian ini dapat digunakan oleh:

- Pentadbir kolej dan pensyarah untuk merangka pendekatan pedagogi berasaskan kelestarian.

1.5.4 Memperkasa Pelajar sebagai Agen Perubahan Hijau

Kajian ini juga penting untuk:

- Meningkatkan kesedaran diri pelajar terhadap tanggungjawab alam sekitar.

- Menyemai nilai lestari dan kepimpinan hijau dalam kalangan belia.
- Membina generasi teknokrat hijau yang mampu beradaptasi dengan cabaran Revolusi Industri 4.0 secara mampan.

1.6 Batasan Kajian

Walaupun kajian ini dijalankan dengan pendekatan sistematik dan berasaskan kerangka konsep yang relevan, beberapa batasan telah dikenal pasti yang mungkin mempengaruhi keluasan dan kebolehgunaan dapatan kajian:

1.6.1 Skop Terhad kepada Satu Institusi

Kajian ini hanya melibatkan pelajar dari Kolej Komuniti Seberang Jaya (KKSJ). Justeru, hasil dapatan mungkin tidak dapat digeneralisasikan kepada keseluruhan populasi pelajar Kolej Komuniti di Malaysia, memandangkan terdapat perbezaan konteks institusi, demografi pelajar dan pendedahan kepada inisiatif hijau.

1.6.2 Reka Bentuk kuantitatif Deskriptif

Penggunaan kaedah kuantitatif deskriptif memberi ruang kepada pemahaman mendalam terhadap persepsi dan pengalaman pelajar. Namun begitu, dapatan kajian bergantung kepada subjektiviti interpretasi responden dan penyelidik.

1.6.3 Keterbatasan Sampel dan Respons

Pemilihan responden berdasarkan teknik persampelan mungkin menyebabkan keterbatasan dalam kepelbagaian latar belakang, program pengajian dan tahap pendedahan kepada amalan hijau. Tambahan pula, keterbukaan responden untuk berkongsi pandangan sebenar berkaitan kesedaran dan penglibatan hijau mereka mungkin dipengaruhi oleh norma sosial atau persepsi terhadap pihak kolej.

2. Tinjauan Literatur

Tinjauan literatur bagi kajian ini akan membincangkan mengenai literasi hijau menekankan kepada jurang pengetahuan-amalan, cabaran pelaksanaan pendidikan hijau, dan relevansi terhadap agenda SDG dan TVET Hijau.

2.1 Literasi Hijau sebagai Asas Pendidikan Lestari

Literasi hijau merujuk kepada tahap pengetahuan, kesedaran, nilai dan kemahiran individu dalam memahami serta bertindak terhadap isu-isu alam sekitar secara bertanggungjawab (Salleh et al., 2021). Konsep ini bukan sahaja merangkumi pemahaman terhadap cabaran ekologi, tetapi juga keupayaan untuk membuat keputusan dan melaksanakan tindakan yang menyokong pembangunan mampan. Dalam konteks pendidikan, literasi hijau dilihat sebagai asas penting dalam membentuk pelajar yang beretika, celik alam sekitar dan berperanan aktif dalam menjaga keseimbangan antara pembangunan dan pemuliharaan.

2.2 Peranan TVET dalam Meningkatkan Literasi Hijau

Institusi Pendidikan dan Latihan Teknikal dan Vokasional (TVET) merupakan platform penting dalam pembangunan modal insan yang bukan sahaja mahir secara teknikal tetapi juga berdaya saing dan berwawasan kelestarian (Md Nor, 2022). Pendidikan TVET yang menyepadukan elemen teknologi hijau, pemuliharaan sumber dan amalan tenaga cekap dapat mempersiapkan pelajar untuk menjadi agen perubahan dalam sektor industri dan komuniti. Walaubagaimanapun, menurut Noraini dan Latifah (2021), integrasi pendidikan alam sekitar dalam kurikulum TVET di Malaysia masih belum dilaksanakan secara menyeluruh dan sistematik. Keadaan ini menyebabkan nilai-nilai kelestarian belum sepenuhnya diterapkan dalam kurikulum TVET.

2.3 Hubungan Literasi Hijau dan Matlamat Pembangunan Mampan (SDG)

Literasi hijau berkait rapat dengan beberapa Matlamat Pembangunan Mampan (Sustainable Development Goals – SDG), khususnya SDG 4 (Pendidikan Berkualiti), SDG 11 (Bandar dan Komuniti Lestari), dan SDG 13 (Tindakan Terhadap Perubahan Iklim). Pelajar yang celik hijau bukan sahaja mampu mengamalkan gaya hidup lestari, malah dapat mempengaruhi orang sekeliling untuk bersama-sama menyokong agenda kelestarian. Menurut laporan UNDP (2022), pendidikan merupakan tunjang utama dalam usaha mencapai SDG, dan literasi hijau ialah komponen penting dalam memastikan pendidikan memberi impak jangka panjang kepada masyarakat dan alam sekitar.

2.4 Dapatan Kajian Lepas Berkaitan Pelajar TVET

Pelaksanaan pendidikan berasaskan kelestarian dalam kalangan pelajar Pendidikan dan Latihan Teknikal dan Vokasional (TVET) semakin mendapat perhatian dalam wacana global dan dasar negara. Namun, pelbagai kajian lepas menunjukkan bahawa tahap literasi hijau pelajar TVET masih berada pada tahap yang membimbangkan, terutamanya dari sudut penghayatan dan pengamalan.

Kajian oleh Khairul et al. (2020) menunjukkan bahawa pelajar institusi TVET di Malaysia memiliki tahap pengetahuan sederhana terhadap isu kelestarian seperti perubahan iklim, pencemaran dan tenaga boleh diperbaharui. Walaupun mereka dapat mengenal pasti istilah dan konsep asas teknologi hijau, dapatan menunjukkan bahawa pengetahuan tersebut tidak diterjemahkan secara aktif dalam tindakan seharian. Kajian tersebut menyimpulkan bahawa terdapat jurang yang ketara antara pengetahuan teori dan pengamalan praktikal dalam kalangan pelajar.

Sementara itu, Noraini dan Latifah (2021) menegaskan bahawa pengajaran berasaskan kelestarian di institusi TVET masih dilaksanakan secara tidak menyeluruh dan sering kali hanya disampaikan melalui aktiviti sambutan seperti kempen kitar semula atau hari alam sekitar. Pendidikan alam sekitar tidak disepadukan secara sistematik dalam kurikulum atau penilaian, menjadikan pelajar tidak memandang serius nilai-nilai kelestarian sebagai komponen penting dalam pembentukan sahsiah dan identiti profesional mereka.

Dalam kajian yang dijalankan oleh Md Nor. (2022) berkaitan pelaksanaan Green TVET Framework di Politeknik dan Kolej Komuniti, didapati bahawa walaupun sebilangan institusi telah melaksanakan inisiatif kampus hijau dan inovasi teknologi hijau, tahap keterlibatan

pelajar masih bergantung kepada dorongan pensyarah dan kepimpinan institusi. Kurangnya peluang untuk pelajar terlibat secara langsung dalam proses perancangan dan pelaksanaan aktiviti kelestarian menjejaskan keberkesanan proses pembudayaan nilai hijau. elain kajian tempatan, dapatan dari kajian antarabangsa turut menunjukkan pola yang serupa, memperkukuh keperluan pendidikan TVET yang lebih proaktif terhadap kelestarian. UNESCO-UNEVOC (2020) dalam laporan khasnya menyatakan bahawa pelajar TVET di seluruh dunia masih menunjukkan tahap literasi hijau yang rendah, terutamanya dalam membuat keputusan yang lestari di tempat kerja. Pendidikan TVET yang berfokuskan kelestarian masih banyak tertumpu kepada bidang kejuruteraan dan teknologi, manakala aspek nilai, etika dan kepimpinan hijau masih belum diberi perhatian secukupnya.

Dapatan lain oleh Hamzah dan Zainal (2019) pula mendapati bahawa pelajar cenderung melihat isu kelestarian sebagai tanggungjawab pihak institusi atau kerajaan, bukan sebagai peranan individu. Ini menunjukkan wujudnya ketergantungan pemikiran terhadap pihak atasan, dan bukannya sense of ownership terhadap alam sekitar. Kajian ini mencadangkan supaya pendidikan kelestarian bukan sekadar bersifat informatif, tetapi perlu bersifat transformatif – membentuk pelajar yang mampu membuat keputusan lestari dalam kerjaya dan kehidupan harian. Tambahan lagi, Lee dan Ng (2021) dalam kajian mereka di Singapura mencadangkan bahawa pendidikan kelestarian perlu melibatkan pembangunan identiti hijau pelajar – iaitu kesedaran kendiri bahawa mereka merupakan sebahagian daripada sistem alam dan bertanggungjawab terhadap pemuliharaannya. Tanpa nilai dan identiti ini, pengetahuan semata-mata tidak mencukupi untuk mendorong kepada perubahan tingkah laku atau tindakan sebenar.

Secara keseluruhannya, dapatan kajian lepas memberi gambaran bahawa tahap literasi hijau pelajar TVET masih berada pada tahap permulaan. Pelajar belum menghayati sepenuhnya peranan mereka dalam menyumbang kepada pembangunan mampan. Ini memberi isyarat jelas tentang keperluan satu pendekatan lebih menyeluruh, sistematik dan berimpak dalam membangunkan TVET Hijau yang benar-benar mampu menyokong pencapaian SDG 4, SDG 11 dan SDG 13 menjelang tahun 2030.

2.5 Keperluan Penyelidikan Lanjutan

Walaupun pelbagai kajian berkaitan literasi hijau telah dijalankan, kajian secara khusus dalam konteks pelajar kolej komuniti di Malaysia masih terhad. Terdapat keperluan untuk menjalankan kajian secara mendalam bagi memahami perspektif pelajar terhadap literasi hijau dalam konteks institusi, serta mengenal pasti faktor-faktor yang menyokong atau menghalang penglibatan aktif mereka dalam amalan kelestarian.

3. Metodologi Kajian

Metodologi bagi kajian ini akan membincangkan mengenai reka bentuk kajian, cara pengumpulan data, populasi dan kaedah persampelan serta tujuan kajian rintis yang telah dijalankan bagi menguji kesahan borang soal selidik.

3.1 *Reka Bentuk Kajian & Pengumpulan Data*

Kajian ini menggunakan analisis pendekatan kuantitatif deskriptif untuk mengenalpasti skor min secara kaedah tinjauan dan soal selidik digunakan sebagai instrumen kajian. Borang soal selidik telah diedar melalui *google form* dan pelajar dikehendaki memilih jawapan berdasarkan skala likert yang diberi. Aras skala likert tersebut adalah seperti di **Jadual 1.** Item dalam borang soal selidik telah diadaptasi daripada kajian Mohammad Zarul Ikhwan Abd Razak et. al, (2022). Data yang dikumpul telah dianalisis menggunakan IBM Statistical Package for Social Science (SPSS) versi 26.0.

Jadual 1: Skala likert yang digunakan dalam borang soal selidik

Aras	Tahap
1	Sangat Tidak Setuju (STS)
2	Tidak Setuju (TS)
3	Kurang Setuju (KS)
4	Setuju (S)
5	Sangat Setuju (SS)

Item dalam soal selidik (*google form*) dibahagikan kepada dua bahagian seperti berikut:

Bahagian A: Demografi Responden - 2 Soalan
Bahagian B: Literasi hijau dalam kalangan pelajar – 30 soalan

3.2 Populasi dan Kaedah Persampelan

Populasi kajian ialah seramai 190 orang pelajar Kolej Komuniti Seberang Jaya Sesi II: 2024/2025. Kajian ini menggunakan teknik persampelan rawak mudah (simple random sampling) bagi memastikan setiap individu dalam populasi mempunyai peluang yang sama untuk dipilih sebagai responden, sekali gus meningkatkan kebolehpercayaan dan kesahan dapatan kajian. Berdasarkan pengiraan sampel Krejcie dan Morgan (1970) sampel kajian ini adalah seramai 127 orang responden.

3.3 Kajian Rintis

Kajian rintis telah dijalankan terhadap 15 orang pelajar. Menurut Hill, (1998) saiz sampel seramai 10-30 orang memadai untuk memenuhi tujuan perbincangan awal yang berkesan tentang ujian. Nilai kebolehpercayaan (Cronbach's Alpha) yang diperoleh ialah 0.987 dan menunjukkan soal selidik yang dibina adalah pada aras kesahan tinggi.

4. Analisis Dapatan Kajian dan Perbincangan

Skor min telah dianalisis berdasarkan Sumber Rathaneswaary Derbala, dan Ruhizan M. Yasin (2022) untuk menginterpretasi setiap objektif yang dikaji. **Jadual 2** ialah interpretasi skor min bagi skala Likert 5 mata tersebut.

Jadual 2: Jadual interpretasi skor min

Min Skor	Tahap
1.00-2.33	Rendah
2.34-3.66	Sederhana
3.67-5.00	Tinggi

4.1 Analisis Objektif 1: Mengenalpasti tahap pengetahuan tentang kelestaraian hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya.

Jadual 3 menunjukkan analisis skor min bagi setiap pernyataan tahap tahap pengetahuan tentang kelestaraian hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya. Tahap pengetahuan pelajar telah diklasifikasi mengikut Jadual 2.

Jadual 3: Analisis objektif pertama:
(Mengenalpasti tahap pengetahuan tentang kelestarian hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya)

Bil	Item	Skor Min	Tahap
1	Saya mempunyai tahap pengetahuan terhadap isu alam sekitar yang luas.	3.60	Sederhana
2	Saya mendapat ilmu pengetahuan tentang isu alam sekitar dari kempen atau program yang telah diadakan di kolej.	3.68	Tinggi
3	Saya mengetahui kepentingan teknologi hijau dari kempen atau program yang telah diadakan di kolej.	3.63	Sederhana
4	Saya mengetahui maksud setiap warna bagi tong kitar semula iaitu biru, coklat dan jingga.	3.97	Tinggi
5	Saya mengetahui kepentingan pengurusan sisa yang efisien dan sistamatik.	3.76	Tinggi
6	Saya mengetahui kepentingan pengurusan alam sekitar yang sihat dan bersih.	3.91	Tinggi
7	Saya mengetahui kepentingan pemuliharaan air untuk menjamin kelstarian alam sekitar.	3.87	Tinggi
8	Saya mempunyai pengetahuan untuk menjaga alam semulajadi seperti sungai, laut dan hutan.	3.95	Tinggi
9	Saya mempunyai pengetahuan untuk menggunakan sumber tenaga (air, elektrik, sisa pepejal) dengan cermat dalam kehidupan harian.	3.90	Tinggi
10	Saya sedia tahu tentang berkongsi kenderaan adalah tanggungjawab bersama dan menyumbang besar kepada kelestarian ekosistem lebuh raya kita.	3.87	Tinggi
11	Saya mempunyai pengetahuan untuk menghubungi organisasi alam sekitar atau agensi kerajaan yang terdekat sekiranya berlaku masalah alam sekitar.	3.77	Tinggi
12	Saya mempunyai pengetahuan tentang produk-produk yang mesra alam sekitar seperti pembungkus makanan (paper bag).	3.79	Tinggi
13	Saya mempunyai pengetahuan tentang kepentingan Kempen Hijau yang diadakan di luar kolej.	3.76	Tinggi
14	Saya mempunyai pengetahuan tentang teknologi hijau akan meningkatkan kualiti udara dan air.	3.80	Tinggi
15	Saya sedia tahu tentang Pindaan Akta Kualiti Alam Sekeliling 1974 (AKAS 1974) mencadang mewujudkan denda minimum tidak kurang daripada RM5,000 dan denda maksimum tidak lebih RM10 juta kepada pelaku jenayah pencemaran alam sekitar.	3.69	Tinggi
Purata Skor Min		**3.79**	**Tinggi**

Analisis data menunjukkan bahawa tahap pengetahuan pelajar Kolej Komuniti Seberang Jaya terhadap isu alam sekitar dan teknologi hijau berada pada tahap tinggi, dengan purata skor min keseluruhan sebanyak 3.79. Dapatan ini memberi indikasi positif bahawa pelajar telah memiliki asas pengetahuan yang kukuh dalam aspek literasi hijau, yang merupakan salah satu elemen penting dalam membentuk warga TVET yang bertanggungjawab dan bersedia menyokong agenda pembangunan mampan. Antara item yang menunjukkan skor min tertinggi ialah:

- Pengetahuan tentang warna tong kitar semula (skor min = 3.97),
- Penjagaan alam semulajadi seperti sungai, laut dan hutan (3.95),
- Penggunaan tenaga dan sumber dengan cermat dalam kehidupan harian (3.90),
- serta kepentingan pemuliharaan air dan pengurusan alam sekitar yang sihat (masing-masing melebihi 3.85).

Skor tinggi dalam item-item ini menunjukkan pelajar bukan sahaja mengenal pasti elemen penting kelestarian, tetapi juga menunjukkan kecenderungan terhadap tindakan harian yang menyokong kelestarian alam sekitar, seperti penggunaan sumber secara bijak dan pemeliharaan kawasan semulajadi. Dapatan ini selari dengan kajian oleh Khairul et al. (2020) yang menyatakan bahawa pelajar TVET mempunyai pengetahuan asas yang baik terhadap isu kelestarian. Namun begitu, seperti yang ditekankan oleh Noraini dan Latifah (2021), cabaran sebenar ialah bagaimana pengetahuan ini diterjemahkan kepada tindakan yang konsisten dan bermakna. Dalam konteks ini, walaupun pelajar menunjukkan pengetahuan yang tinggi terhadap aspek asas seperti sistem kitar semula dan kepentingan menjaga kebersihan alam sekitar, terdapat beberapa bidang pengetahuan yang masih boleh diperkukuh, khususnya yang melibatkan:

- Tindakan proaktif, seperti menghubungi organisasi alam sekitar sekiranya berlaku pencemaran (item 11, skor min = 3.77),
- *Pemahaman tentang dasar atau undang-undang alam sekitar, contohnya pindaan Akta Kualiti Alam Sekeliling 1974 (item 15, skor min = 3.69).

Perbezaan skor ini mencerminkan bahawa pelajar lebih menguasai pengetahuan berbentuk amalan harian berbanding pengetahuan berbentuk sistemik atau institusional, yang melibatkan peranan undang-undang, polisi kerajaan atau interaksi dengan agensi luar. Ini mungkin disebabkan oleh pendekatan pendidikan semasa yang lebih banyak menekankan kesedaran umum berbanding pemahaman dasar dan kerangka pengurusan alam sekitar secara menyeluruh. Tambahan pula, skor tinggi dalam item seperti saya mengetahui tentang produk mesra alam seperti pembungkus makanan jenis '*paper bag*' (item 12, skor min = 3.79) menunjukkan peningkatan tahap kesedaran pengguna dalam kalangan pelajar. Ini merupakan perkembangan yang baik kerana ia selari dengan trend global dalam pembangunan teknologi hijau dan ekonomi lestari, di mana pengguna bijak alam sekitar menjadi pemacu perubahan.

Secara keseluruhannya, dapatan ini memperkukuh keperluan untuk memperkasa pendekatan pendidikan kelestarian secara holistik, bukan sahaja dari aspek pengetahuan umum tetapi juga penguasaan terhadap dasar, tindakan sivik, dan peranan kepimpinan alam sekitar. Pelajar bukan sekadar perlu tahu "apa" dan "kenapa", tetapi juga "bagaimana" dan "siapa"

yang harus mereka libatkan untuk menjadi agen perubahan sebenar. Cadangan intervensi termasuk:

- Integrasi modul dasar-dasar hijau dan peranan organisasi alam sekitar dalam kursus umum,
- Simulasi atau aktiviti lapangan berkaitan tindakan terhadap insiden pencemaran,
- serta projek kolaboratif bersama agensi luar untuk mendedahkan pelajar kepada tanggungjawab sivik dalam konteks alam sekitar.

Langkah ini diyakini dapat meningkatkan lagi tahap literasi hijau pelajar secara menyeluruh, dan menyumbang secara langsung kepada pencapaian SDG 4 (Pendidikan Berkualiti) dan SDG 13 (Tindakan terhadap Perubahan Iklim) melalui pendekatan pendidikan transformatif di peringkat institusi TVET.

4.2 Analisis Objektif 2: Meninjau amalan pelajar Kolej Komuniti Seberang Jaya terhadap kelestarian hijau

Jadual 4 menunjukkan analisis skor min bagi setiap pernyataan amalan pelajar Kolej Komuniti Seberang Jaya terhadap kelestarian hijau. Tahap amalan pelajar telah diklasifikasi mengikut Jadual 2.

Jadual 4: Analisis Objektif Kedua
(Meninjau amalan pelajar Kolej Komuniti Seberang Jaya terhadap kelestarian hijau)

Bil	Item	Skor Min	Tahap
1	Saya menyokong kempen alam sekitar atau teknologi hijau yang diadakan di dalam dan luar kolej.	3.94	Tinggi
2	Saya menggunakan konsep 3R (reduce, reuse, recycle) dalam aktiviti harian.	3.80	Tinggi
3	Saya kurang memandu kereta dan lebih mengamalkan berkongsi kereta untuk menjimatkan tenaga.	3.65	Sederhana
4	Saya membawa bekas sendiri apabila membeli makanan.	3.45	Sederhana
5	Saya memilih barang keperluan harian yang memberi kebaikan kepada alam sekitar.	3.72	Tinggi
6	Saya menukar produk harian atas keprihatinan terhadap alam sekitar.	3.72	Tinggi
7	Saya menggunakan sumber tenaga (air, elektrik, sisa pepejal) dengan cermat dalam kehidupan harian.	3.86	Tinggi
8	Saya menjaga alam semulajadi seperti sungai, laut dan hutan.	3.89	Tinggi
9	Saya menjaga alam sekitar untuk kepentingan kepada persiktaran saya.	3.91	Tinggi
10	Saya membiasakan diri untuk tidak melakukan sebarang aktiviti yang memberi kesan negatif kepada teknologi hijau.	3.87	Tinggi
11	Saya memaklumkan kepada organisasi alam sekitar atau agensi kerajaan yang terdekat sekiranya berlaku masalah alam sekitar.	3.75	Tinggi
12	Saya menguruskan sebarang sisa yang memudaratkan alam sekitar dengan efisien dan sistamatik,	3.75	Tinggi

13	Saya sanggup menyumbang wang saya untuk menjamin kelesteraian hijau.	3.69	Tinggi
14	Saya mengamalkan produk-produk yang mesra alam sekitar seperti pembungkus makanan (paper bag) dalam kehidupan harian.	3.72	Tinggi
15	Saya memberi kesedaran kepada keluarga dan juga rakan-rakan sebaya saya tentang penggunaan produk hijau.	3.81	Tinggi
Purata Skor Min		**3.77**	Tinggi

Dapatan kajian menunjukkan bahawa tahap pengamalan kelestarian alam sekitar dalam kalangan pelajar Kolej Komuniti Seberang Jaya adalah berada pada tahap tinggi secara keseluruhan, dengan purata skor min keseluruhan sebanyak 3.77. Nilai ini menunjukkan bahawa sebahagian besar pelajar bukan sahaja mempunyai pengetahuan tentang isu kelestarian, tetapi juga mengaplikasikan pengetahuan tersebut dalam amalan harian, selaras dengan konsep literasi hijau yang menyatukan elemen pengetahuan, kesedaran dan tindakan. Item yang memperoleh skor tertinggi ialah:

- Saya menyokong kempen alam sekitar atau teknologi hijau yang diadakan di dalam dan luar kolej (skor min = 3.94),
- Saya menjaga alam sekitar untuk kepentingan kepada persekitaran saya (3.91),
- Saya menjaga alam semulajadi seperti sungai, laut dan hutan (3.89),
- Saya tidak melakukan aktiviti yang memberi kesan negatif kepada teknologi hijau (3.87),
- dan Saya menggunakan sumber tenaga dengan cermat (3.86).

Ulasan terhadap item-item ini menunjukkan bahawa pelajar menunjukkan sikap proaktif dan bertanggungjawab dalam menjaga alam sekitar, khususnya dalam aspek penggunaan tenaga dan pemeliharaan sumber semula jadi. Ini merupakan satu perkembangan yang positif dan sejajar dengan hasrat Matlamat Pembangunan Mampan (SDG), khususnya SDG 13 (Tindakan Terhadap Perubahan Iklim) dan SDG 11 (Bandar dan Komuniti Lestari). Walau bagaimanapun, terdapat beberapa item yang menunjukkan tahap amalan yang sederhana, khususnya:

- Saya membawa bekas sendiri apabila membeli makanan (skor min = 3.45),
- Saya kurang memandu kereta dan lebih mengamalkan berkongsi kereta untuk menjimatkan tenaga (3.65),
- dan Saya sanggup menyumbang wang untuk menjamin kelestarian hijau (3.69).

Dapatan ini mencerminkan cabaran dari sudut konsistensi tingkah laku hijau, khususnya apabila ia melibatkan perubahan gaya hidup yang memerlukan usaha lebih, seperti membawa bekas sendiri atau berkongsi kenderaan. Hal ini selaras dengan kajian oleh Anderson dan Soh (2018) yang menyatakan bahawa walaupun pelajar mempunyai sikap positif terhadap kelestarian, amalan sebenar sering dipengaruhi oleh keselesaan peribadi, kekangan kemudahan

dan norma sosial. Menariknya, pelajar menunjukkan skor tinggi dalam aspek pengaruh sosial dan kepimpinan hijau, seperti item Saya memberi kesedaran kepada keluarga dan rakan-rakan tentang penggunaan produk hijau (3.81), dan Saya menguruskan sisa dengan efisien dan sistematik (3.75). Ini menunjukkan bahawa pelajar bukan sahaja bertindak secara individu, tetapi turut memainkan peranan sebagai agen penyebar nilai kelestarian kepada komuniti sekeliling mereka – satu indikator penting dalam pembentukan identiti hijau dan pembudayaan nilai lestari dalam komuniti TVET. Secara keseluruhan, dapatan ini mengesahkan bahawa tahap pengamalan pelajar terhadap kelestarian berada pada landasan yang baik. Namun demikian, terdapat keperluan untuk memperkukuhkan transformasi tingkah laku lestari melalui pendekatan pendidikan yang lebih berasaskan pengalaman sebenar, galakan norma hijau, dan penyediaan fasiliti yang menyokong gaya hidup hijau secara praktikal. Dapatan ini menyokong keperluan untuk:

- Integrasi kokurikulum hijau yang memfokuskan kepada tindakan sebenar dan cabaran harian,
- Insentif atau ganjaran untuk mendorong perubahan tingkah laku,
- serta kerjasama komuniti dan industri hijau untuk mendedahkan pelajar kepada amalan kelestarian dalam konteks sebenar.

Dengan pendekatan ini, institusi TVET bukan sahaja dapat meningkatkan keberkesanan pendidikan hijau, malah menyumbang kepada matlamat jangka panjang pembentukan masyarakat lestari dan ekonomi rendah karbon.

4.3 *Analisis Objektif 3: Mengukur korelasi/hubungan pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya.*

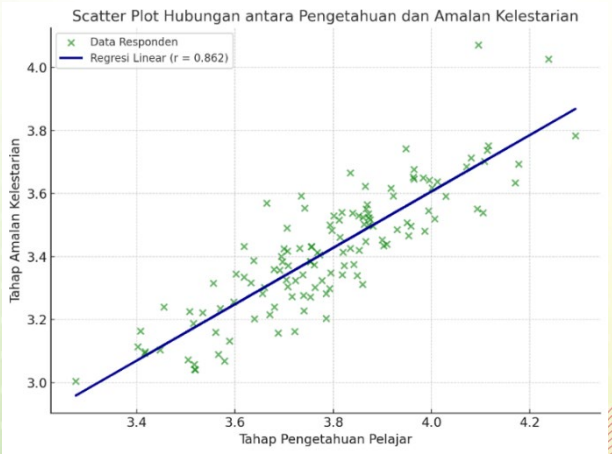
Jadual 5 menunjukkan korelasi/hubungan pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya.

Jadual 5: Korelasi/hubungan pengetahuan dan amalan pelajar terhadap kelestarian hijau di Kolej Komuniti Seberang Jaya

Correlations			
		PENGETAHUANOVERALL	AMALANOVERALL
PENGETAHUANOVERALL	Pearson Correlation	1	.917**
	Sig. (2-tailed)		.000
	Sum of Squares and Cross-products	92.083	83.648
	Covariance	.731	.664
	N	127	127
AMALANOVERALL	Pearson Correlation	.917**	1
	Sig. (2-tailed)	.000	

	Sum of Squares and Cross-products	83.648	90.327
	Covariance	.664	.717
	N	127	127
**. Correlation is significant at the 0.01 level (2-tailed).			

Berdasarkan Jadual 5, dapatan analisis korelasi Pearson menunjukkan bahawa terdapat hubungan yang sangat kuat dan signifikan secara statistik antara tahap pengetahuan pelajar dan amalan kelestarian alam sekitar. Mengikut Rajah 1.0, nilai korelasi yang diperoleh ialah r = 0.917 pada aras signifikansi p=0.00 < 0.01. Ini bermakna, semakin tinggi tahap pengetahuan pelajar tentang isu alam sekitar dan teknologi hijau, semakin tinggi juga kecenderungan mereka untuk mengamalkan kelestarian dalam kehidupan harian. Nilai korelasi 0.917 berada dalam kategori korelasi sangat tinggi menurut tafsiran umum (Cohen, 1988), sekaligus memperkukuh hipotesis bahawa pengetahuan memainkan peranan besar dalam membentuk tingkah laku pelestarian. Ia menggambarkan bahawa pelajar yang celik tentang kepentingan penjagaan alam sekitar, teknologi hijau, dan kesan pencemaran lebih berpotensi untuk mempraktikkan gaya hidup lestari seperti amalan 3R, penjimatan tenaga, penggunaan produk mesra alam, serta penyertaan dalam kempen hijau. Kewujudan korelasi yang signifikan ini turut menyokong dapatan beberapa kajian lepas. Salleh et al. (2021) menegaskan bahawa peningkatan pengetahuan hijau melalui pendidikan formal boleh mengubah paradigma pelajar terhadap isu alam sekitar dan mencetuskan perubahan tingkah laku. Md Nor (2022) pula menyatakan bahawa pelajar TVET yang terdedah kepada literasi hijau bukan sahaja menunjukkan peningkatan kesedaran, tetapi juga mula membudayakan tindakan pro-lestari dalam rutin harian mereka. Justeru, hubungan erat antara pengetahuan dan amalan yang ditunjukkan dalam kajian ini adalah selari dengan teori pendidikan kelestarian global. Daripada aspek praktikal, dapatan ini memberikan impak besar kepada pembangunan kurikulum dan strategi pendidikan di institusi TVET, khususnya di Kolej Komuniti. Ia memberi justifikasi kukuh bahawa penyampaian pengetahuan yang berstruktur dan berasaskan pengalaman sebenar alam sekitar mampu membentuk pelajar yang bukan sahaja berilmu, tetapi juga beramal dengan nilai hijau. Dalam konteks pembangunan insan holistik, dapatan ini memperlihatkan keperluan agar pendidikan hijau tidak hanya dilihat sebagai pelengkap, tetapi menjadi komponen teras dalam setiap program latihan teknikal.



Rajah 1: Scatter plot lengkap dengan garis regresi linear

Implikasi ini turut berkait secara langsung dengan pencapaian Matlamat Pembangunan Mampan (SDG):

- SDG 4 (Pendidikan Berkualiti) melalui integrasi pendidikan alam sekitar dalam kurikulum,
- SDG 11 (Bandar dan Komuniti Lestari) dengan melahirkan individu yang menyumbang kepada ekosistem setempat,
- dan SDG 13 (Tindakan Terhadap Perubahan Iklim) melalui amalan hijau yang dapat mengurangkan impak karbon dalam kehidupan harian.

Kesimpulannya, hubungan yang sangat signifikan dan kuat ini mengesahkan bahawa usaha untuk meningkatkan pengetahuan pelajar tentang kelestarian adalah pelaburan strategik yang memberi pulangan tingkah laku positif, selaras dengan aspirasi TVET Hijau, Pelan Strategik JPPKK, dan dasar pendidikan negara ke arah ekonomi hijau.

5. Kesimpulan & Cadangan

Bab 5 ini akan membincangkan mengenai kesimpulan daripada analisis dapatan kajian yang telah dijalankan dan cadangan untuk manambahbaik tahap literasi hijau dalam kalangan pelajar kolej komuniti.

5.1 Kesimpulan

Kajian ini telah berjaya meneroka tahap literasi hijau dalam kalangan pelajar Kolej Komuniti Seberang Jaya (KKSJ) dengan memberi fokus kepada tiga komponen utama iaitu pengetahuan, pengamalan dan hubungan antara kedua-duanya. Hasil analisis menunjukkan bahawa pelajar secara umum mempunyai tahap pengetahuan yang tinggi tentang isu-isu alam sekitar dan teknologi hijau, diikuti dengan tahap pengamalan kelestarian yang juga tinggi, walaupun terdapat beberapa aspek tingkah laku hijau yang masih pada tahap sederhana. Ini menunjukkan bahawa pendidikan kesedaran alam sekitar yang telah dilaksanakan di institusi ini telah membuahkan hasil yang positif.

Pengetahuan pelajar adalah tinggi khususnya dalam aspek seperti penjagaan alam semulajadi, penggunaan tenaga secara cermat, dan pengurusan sisa, serta pemahaman terhadap kempen dan produk mesra alam. Hal ini menggambarkan keberkesanan penyampaian ilmu melalui pelbagai saluran seperti kempen kolej, program luar dan pendedahan umum terhadap isu alam sekitar. Dalam masa yang sama, pelajar menunjukkan kecenderungan tinggi untuk mengamalkan gaya hidup hijau, termasuk sokongan terhadap kempen kelestarian, penyebaran kesedaran kepada keluarga dan rakan, serta pengurusan sumber tenaga secara bertanggungjawab.

Namun, kajian ini turut mendedahkan wujudnya jurang amalan dalam aspek tindakan proaktif, seperti membawa bekas makanan sendiri, berkongsi kenderaan, dan membuat aduan kepada agensi berkaitan pencemaran. Ini menunjukkan bahawa sebahagian aspek amalan kelestarian memerlukan lebih banyak intervensi berbentuk pengalaman sebenar dan motivasi intrinsik pelajar.

Dapatan paling signifikan dalam kajian ini ialah hubungan yang sangat kuat dan signifikan antara tahap pengetahuan dan amalan kelestarian, dengan nilai korelasi Pearson r =

0.917, $p < 0.01$. Ini membuktikan bahawa peningkatan literasi hijau dari sudut pengetahuan berpotensi memberi kesan langsung terhadap tindakan dan gaya hidup pelajar. Hubungan ini sekali gus mengesahkan hipotesis utama bahawa pendidikan hijau memainkan peranan kritikal dalam pembentukan tingkah laku lestari dalam kalangan pelajar TVET.

Secara keseluruhan, kajian ini membuktikan bahawa Kolej Komuniti berperanan besar dalam menyumbang kepada agenda pembangunan mampan negara. Pelajar sebagai bakal tenaga kerja masa hadapan perlu bukan sahaja mahir secara teknikal, tetapi juga celik terhadap nilai dan tanggungjawab alam sekitar. Kajian ini memberi justifikasi yang kukuh bahawa pendidikan kelestarian bukan sahaja relevan, tetapi mesti dijadikan komponen teras dalam transformasi sistem TVET selaras dengan keperluan Revolusi Industri 4.0 dan cabaran perubahan iklim global.

Sebagai rumusan, kajian ini bukan sahaja menilai tahap literasi hijau pelajar, tetapi juga memberi cadangan bernilai tinggi kepada pihak institusi, penggubal dasar dan pengamal pendidikan untuk membentuk strategi pembelajaran hijau yang lebih berfokus, bersifat transformatif dan mampu membina pelajar sebagai agen perubahan sejati. Dengan pengukuhan pendidikan hijau secara sistematik, institusi TVET akan terus relevan dan menyumbang secara langsung kepada pencapaian Matlamat Pembangunan Mampan (SDG), khususnya SDG 4, SDG 11 dan SDG 13, dalam kerangka masa yang ditetapkan.

5.2 Cadangan

Berikut adalah cadangan untuk manambahbaik tahap literasi hijau dalam kalangan pelajar kolej komuniti.

5.2.1 Integrasi Sistematik Literasi Hijau dalam Kurikulum

Kementerian dan pihak institusi disarankan untuk memperkukuh pengintegrasian elemen kelestarian dalam kurikulum program TVET secara formal dan menyeluruh. Pendidikan literasi hijau seharusnya tidak terhad kepada kursus tertentu, tetapi perlu dimasukkan secara merentas disiplin dan bersifat lintas bidang agar semua pelajar, tanpa mengira jurusan, dapat menguasai pengetahuan dan nilai berkaitan kelestarian.

5.2.2 Pendekatan Pembelajaran Berasaskan Pengalaman (Experiential Learning)

Pelajar menunjukkan tahap amalan sederhana dalam tindakan-tindakan yang memerlukan komitmen tingkah laku jangka panjang (seperti membawa bekas makanan dan berkongsi kenderaan). Oleh itu, disarankan agar pendekatan project-based learning (PBL), service learning dan aktiviti komuniti hijau diterapkan secara aktif bagi menanam nilai hijau melalui pengalaman sebenar. Ini termasuk program penanaman pokok, audit tenaga kampus, dan inovasi pelajar dalam teknologi hijau.

5.2.3 Pengukuhan Kerjasama Industri dan Agensi Alam Sekitar

Pihak kolej perlu menjalin kerjasama strategik dengan agensi berkaitan seperti DOE, SWCorp, MESTECC dan industri hijau tempatan dalam merangka program kesedaran dan

latihan luar. Pendedahan ini dapat mendedahkan pelajar kepada realiti semasa dalam pengurusan kelestarian, seterusnya menggalakkan tindakan proaktif seperti membuat aduan terhadap pencemaran dan menyumbang kepada dasar awam.

5.2.4 Galakan Tingkah Laku Hijau melalui Sistem Insentif

Bagi mendorong perubahan tingkah laku yang konsisten, pihak institusi disaran membina mekanisme insentif atau pengiktirafan seperti markah merit hijau, sijil penyertaan lestari, atau geran mini hijau untuk projek pelajar. Langkah ini boleh memotivasikan pelajar untuk mengamalkan gaya hidup hijau secara berterusan dan bukan semata-mata kerana keperluan akademik. Cadangan-cadangan ini diharap dapat membantu memperkukuh peranan institusi TVET sebagai pemangkin kepada pembentukan masyarakat celik kelestarian serta menyumbang secara langsung kepada pencapaian SDG 4 (pendidikan berkualiti), SDG 11 (komuniti lestari), dan SDG 13 (tindakan terhadap perubahan iklim).

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Evaluating Low-Cost Material Substitutes for Crump Weirs: Ensuring Instructional Accuracy in Measuring Specific Energy

Tan Siew Ning[1*]

Civil Engineering Dept., No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah

*siewning@polikk.edu.my

ABSTRACT

The precise measurement of flow using Crump weirs is important in civil engineering teaching, especially in teaching about specific energy and flow losses. However, many polytechnic and technical colleges still use obsolete or warped plastic Crump weirs in their multipurpose flume systems. Such a state undermines the precision and trustworthiness of educational and instructional experiments. This investigation is directed toward low-cost replacements for damaged plastic weirs and examines whether plywood and concrete would adequately serve in the laboratory setting without compromising the educational focus. For the evaluation, Crump weirs of three different materials—acrylic plastic, plywood, and concrete—were constructed for use in a 5-metre laboratory flume which was not calibrated. The discharge was measured using the volume-over-time method and specific energy was calculated in five different, controllable flow rates. Moreover, the materials' deformation or surface changes underwent visual inspection. The experimental findings showed that all three materials, when maintained identical in geometric profile of the weir and underwent minor surface deformation, produced identical measurements. Concrete was the best performing among the three materials. While more coarse in texture, plywood preserved sufficient accuracy in instruction and did not create substantial discrepancies in specific energy or flow loss measurements. On the other hand, the currently used plastic weir both observed and over-reflected high flowrate measurement errors due to visible cracks and deformations. These results show that inexpensive materials, like plywood, can be used in teaching activities as long as the shape of the Crump weir is kept accurately. This reinforces the growing need for inexpensive and easily reproducible teaching aids in engineering and vocational education and highlights the need for precision in geometry over stiffness of materials for reproducible results in the laboratory.

Keywords: *Crump weir; specific energy; low-cost materials; geometry consistency; educational tools*

1. Introduction

In socio-economic development, research proves that water is a major resource that needs to be managed; however, in engineering it is important to control water in irrigation and design water a particular structure in a manageable way (Chow, 1959; Chanson, 2001). In practical and teaching environments, Crump weirs serve important functions as teaching tools and are used as flow measuring devices that are easy to construct and provide accurate and repeatable results, as well as illustrating major terminal hydraulics which encompass channel flow, specific energy, and critical depth (Crump & Burkitt, 1952).

Crump weirs assist students in appreciating not only hydraulics and mechanical departments, but also in information and science due to the advantages found within (Wessels & Rooseboom, 2009). These include stable and constant discharge coefficients below moderate flow damping which causes a discharge level to remain stable without a rising dip in water, as well as steady flow conditions of moderate submergence sensitivity level. In the flow of open channel hydraulics, energy (E) needs to be constant in specific ways to prevent fresher water crossing that section of energetic balance. The effectiveness of Crump weirs in teaching settings has long been overshadowed; Crump weirs are plastic weirs that are readily available in the market. The cracks, defects, and deformation of plastic weirs significantly age or disable them and thus decrease the effectiveness of teaching in the long run (Oertel & Shen, 2022).

The plastic form of weirs always seemed appealing due to being inexpensive, lightweight, and easy to obtain. Repeated use of plastic weirs resulted in cracking, warping, and deformation, which in turn decreased the weirs' ability to measure things accurately; age plastic weirs increased their ineffectiveness. The ability of cheap substitutes like plywood and modified concrete to replace deteriorating plastic requires consideration as crucial alternatives. This question brings to the forefront the topic of the plastic weirs' ability to replace plywood or care of plastic with more robust materials. This form brings to the forefront the necessity to teach with readily accessible materials, while also ensuring instructional dependability. This paper focuses on the problem of what materials are best to use for Crump weirs in the context of uncalibrated classroom settings.

The aim is to find resources that help teach hydraulics in a greener way while also ensuring low cost, ease of fabrication, and measurement precision.

1.1 Research Contribution

This research addresses issues with sustainable practices in engineering and educational pedagogy. It provides evidence for using low-cost materials such as plywood and plastic for building Crump weirs in educational laboratories and for TVET colleges and schools. The findings demonstrate that instructional rigor in hydraulic practices can be maintained even if one does not use conventional materials. The conclusions not only enrich curriculum and module planners as they advocate for the use of modular aid devices which are structured to fit instructional methods that emphasise experience and hands-on activities. This research enhances pedagogy and the practice of teaching fluid mechanics by enabling students to perform hydraulic experiments that are reproducible, accessible, and impactful. The research also advocates for the need to use portable and reusable items for instructional aids from the perspective of sustainability. This approach not only promotes sustainability but also helps educational institutions achieve their goals of reducing material waste and promoting long-term cost efficiency.

1.2 Objectives

1. To fabricate Crump weirs using acrylic plastic, plywood, and concrete with consistent geometrical specifications.
2. To measure and compare hydraulic behavior (discharge, Q and specific energy, E) of each weir using a basic laboratory flume.
3. To evaluate the feasibility of adopting alternative materials in hydraulic teaching setups from the perspectives of accuracy, cost, and ease of construction.

1.3 Scope of Study

The current research focuses on the assessment of small-scale Crump weirs only within the confines of a controlled laboratory setting. The weirs are tested under flow rates ranging from 2 to 10 litres per minute, which reflects typical limits encountered in educational institutions. The flowing measurement technique of volume-over-time (V/t) is applied, and, for the measurement, no sophisticated devices are utilised. The study does not include large-scale hydraulic modelling or fieldwork in actual hydraulic systems.

2. Literature Review

Crump weirs have been noted for their effectiveness in maintaining critical flow conditions and accurate measurement in different hydraulic settings. They serve well in both field and experimental settings due to their simple triangular shape and consistent hydraulic performance. A weir's geometry and shape greatly influence its hydraulic performance rather than the material used. This has been emphasised by Chanson (2004) in the context of alternative materials for teaching or practical activities.

Lately, research has been conducted on the impact that small deviations from the standard Crump weir profile might have on the flow characteristics. Al-Naely, Al-Khafaji, and Khassaf (2018) proved, for instance, that the addition of apertures on the body of a Crump weir changes its energy dissipation and discharge capacity. This shows that measurement accuracy can be influenced by small alterations to a design. This reinforces the importance of meticulous design strategy, both for field installations and laboratory work.

Selecting appropriate materials becomes vital when ease of construction, durability, and cost-effectiveness come into play. Throughout hydraulic laboratories, plastic crump weirs are commonplace, given their low cost and ease of manufacturing. Oertel and Shen (2022) mention the concern of plastic models deforming with repeated use, thus reducing precision and producing inconsistent measurements among students.

In some instructional contexts, wooden weirs have been used as cheaper alternatives. While these tend to be accurate in the measurement of flow, wooden weirs are susceptible to water roughness, and prolonged exposure may lead to swelling, dimensional changes, or other forms of distortions. Still, wood offers a reasonable functionality-price ratio, enabling it to be employed in low-budget and temporary projects.

Concrete remains the traditional go-to material for weir construction owing to its strength and dimensional stability with enduring deformations. This makes it ideal for both calibrated and uncalibrated flow measurement investigations. However, concrete may not be very appropriate for teaching contexts that require these structures to be portable and easy to handle. Their weight and intricate construction adds to the bulk (Amin, Khan, & Ajmal, 2019).

Table 2.1 Summary related to Crump weir

Author(s)	Year	Focus	Material	Calibration	Education Relevance
Chow	1959	Fundamental open-channel hydraulics; specific energy concepts	General	Yes	High
Chanson	2004	Weir hydraulics and energy concepts in laboratory channels	Concrete	Yes	Indirect
Chanson	2001	Hydraulic design of stepped spillways and downstream energy dissipators	Concrete	No	Partial
Crump & Burkitt	1952	Original design and application of submerged Crump weir profile	Concrete	Yes	High
Wessels & Rooseboom	2009	Flow-gauging structures and field calibration for Crump weirs	Concrete	Yes	Limited

Idrees et al	2024	Influence of surface roughness on flow profiles	Concrete	Yes	Limited
Keller	1989	Sloping crest Crump weir design for improved accuracy	Concrete	Yes	High
Al-Naely et al.	2018	Effect of opening holes on Crump weir hydraulic performance	Concrete / Modified	No	Partial
Razi et al.	2008	Unsteady open-channel flow characteristics over Crump weir	Plastic	No	High
Al-Shukur et al.	2017	Experimental flow tests on Crump weir under different conditions	Plastic	No	High
Oertel & Shen	2022	3D printing technique for weir models; plastic deformation issues	Plastic / Polymer	No	High
Amin et al.	2019	Comparison of gabion and reinforced concrete weirs	Concrete / Gabion	Yes	Indirect

Table 2.1 compiles the notable research on the performance of Crump weirs, including material selection, calibration, and their effects on education in hydraulics (Chanson, 2004; Wessels & Rooseboom, 2009; Oertel & Shen, 2022). Most of the existing literature, as noted, has focused on field calibration or controlled lab environments, completely disregarding the complexities and unpredictability of the real-world scenario that TVET institutions grapple with (Razi et al., 2008; Al-Shukur et al., 2017).

The geometry of crump weirs, as well as their discharge and calibration behaviours, has been well documented (Crump & Burkitt, 1952; Keller, 1989; Al-Naely et al., 2018). There is, however, a gap in understanding the performance of these structures in uncalibrated or semi-calibrated teaching flumes made from wood and plastic. These teaching models may undermine standardisation and learning variability (Oertel & Shen, 2022).

This gap is addressed by analysing the impact of different construction materials—namely, wood, plastic, and concrete—on discharge measurement and specific energy calculations, assuming a fixed weir profile. The research will aid in the future resource allocation and material selection for educational hydraulic laboratories (Chow, 1959; Amin et al., 2019).

2.1 Specific Energy and Educational Relevance

In hydraulic engineering, specific energy is a fundamental concept used to analyze and classify open channel flow behavior. It is defined as the total mechanical energy per unit weight of water, measured relative to the channel bed at a given cross-section. The specific energy (E) is calculated as:

$$E = y + \frac{v^2}{2g}$$

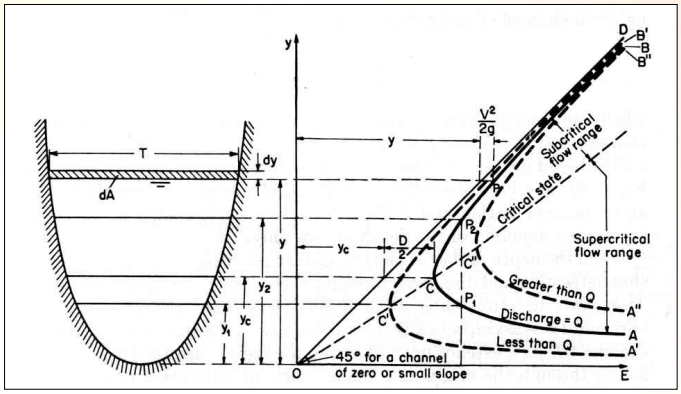
Where:
y = flow depth (m)
v = average velocity of flow (m/s)
g = acceleration due to gravity (9.81 m/s²)

When considering flow per unit width $q = \frac{Q}{b}$ (discharge per unit width), the specific energy equation becomes:

$$E = y + \frac{q^2}{2gy^2}$$

This form is especially useful in laboratory flumes with rectangular cross-sections, such as those used for teaching open channel flow.

The Specific Energy Curve, which plots flow depth against specific energy for a constant discharge, is a crucial tool for visualizing this relationship. The critical depth (yc), where the flow changes from subcritical (deep, slow) to supercritical (shallow, fast) conditions, is where the curve reaches its minimum, as seen in Figure 2.1. The Froude number is now equal to 1.0, indicating that the forces of gravity and inertial motion are balanced.



https://images.app.goo.gl/wQ93W57wB7pcrknW6

Figure 2.1: Specific Energy Curve

This idea is particularly important in teaching with respect to hydraulic laboratories. It is possible to explore the curve with crump weirs and teach students the principles of flow transitions because they measure depth and discharge accurately. This ideal is perhaps impossible to reach in practice, however, because form changes and material instability are capable of influencing data precision. This emphasizes the problem of ascertaining the degree of efficacy of various materials under teaching conditions.

3. Methodology

This research was conducted to assess the flow measurement accuracy of Crump weirs made of different materials – wood, plastic, and concrete – in terms of energy expenditure, within a non-calibrated laboratory flume environment. The primary aim of this approach was to evaluate the impact of material selection on measurement accuracy of the flow rate and specific energy, both of which are pivotal in the field of hydraulic engineering.

3.1 Experimental Setup

As mentioned earlier, the surfaces of the flume and its interior were inspected and cleaned before the experiment so that any debris, algae, sediment build-up, and irregular surfaces that could distort flow and measurement accuracy were dealt with.

Figure 3.1 shows the HM160 laboratory flume unit which forms an integral part of the practicum. The teaching laboratory is often limited in terms of equipment and therefore poses several challenges to its teaching design requiring the full HM160 laboratory flume set-up.



Figure 3.1: HM 160 experimental flume

Proper preparation for the flume setup was needed to achieve realistic laboratory conditions. This preparation ensured the flume was devoid of any blockage, sediment, contours, and irregular surfaces, which would interfere with the flow and measurement of the setup. Cleaning, for example, includes the removal of suspended or attached sediment and algae on the flume surfaces (Figure 3.2).



Figure 3.2: Initial Flume Setup

As depicted in Figure 3.3, a Crump weir with an upstream slope of 1:2 and a downstream slope of 1:5 was made from steel, concrete, wood and plastic creating a triangular-profiled Crump weir. To ensure that the only variable being tested was the material's properties, all weirs underwent the same geometric measurements. Every weir was carefully constructed to ensure that all geometric measurements were consistent so that any changes in the flow performance could be attributed solely to the material properties.



Figure 3.3: Types of surface

3.2 Flow Rate Measurement Procedure

The flume was calibrated using the volume-over-time (V/t) method, paying attention to the actual flow rate through the flume, which involved collecting a specific amount of water over a set time period (Chow, 1959). For each Crump weir material in the study, five flow rates of 2, 4, 6, 8, and 10 litres per hour were meticulously measured and evaluated (Crump & Burkitt, 1952).

In accordance with measuring each flow rate, water surface elevations were noted at two predetermined points along the flume for each flow rate to monitor any alterations in the flow profile. As per the standard protocol for deriving head-discharge relationships, the elevation data obtained was converted to discharge values with the aid of a predetermined rating curve (Wessels & Rooseboom, 2009). This approach provided reliable results even with a semi-calibrated flume system typical in TVET labs, and it established a dependable relationship between upstream head and discharge.

To enhance consistency and replicability, markers were placed at specific intervals along the flume, as illustrated in Figure 3.4. For each flow condition, the flow was allowed to stabilise for a few minutes prior to measurement. Water depth readings (representing static energy), velocity estimations (representing kinetic energy), and specific energy determined from standard open channel flow equations (Chow, 1959) were all recorded. This allowed every weir material to be analysed for their relative impact on the system's hydraulic performance. Critical aspects like flow uniformity, head-discharge relationship, hydraulic energy dissipation, and energy loss were considered (Chanson, 2004). Following this approach minimised external error factors and provided a reliable measurement of the flow behaviour.

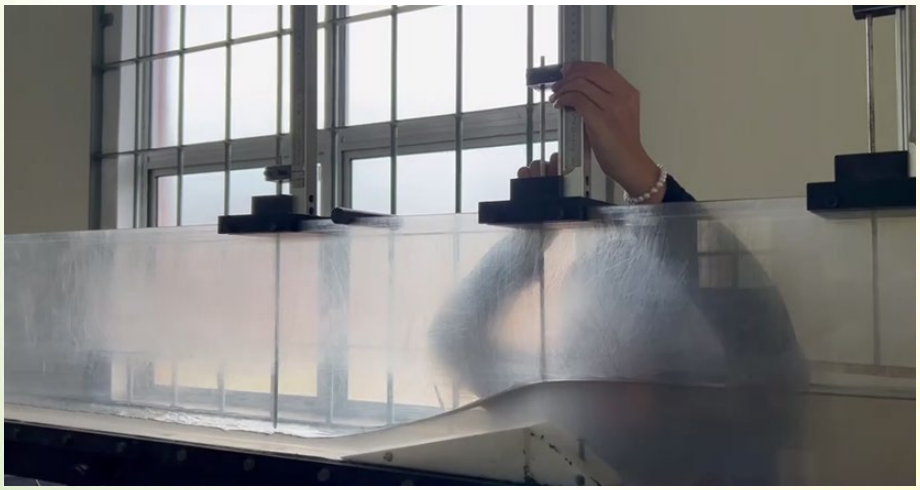


Figure 3.4: Markers to measure the water surface elevation for each flow rate

3.3 Specific Energy Calculation

Each material was assessed separately by substituting the weir design within the same flume. Surface roughness and model making accuracy were held within standard educational workshop tolerances to ensure uniformity across the comparison. Thorough environmental and flow conditions were maintained to limit external variation for the experiment which was conducted multiple times. Specific energy (E) was calculated for each point by summing flow depth and velocity head, as defined by the equation.

3.4 Data Collection and Analysis

This phase of the study examining the hydraulic characteristics of Crump weirs constructed from concrete, wood, and plastic began with collecting and analysing data. Relevant parameters related to the flow were also monitored and measured at different levels of controlled flow.

As described in Table 3.1, the V/t technique was used to determine five flow rates (2, 4, 6, 8, and 10 litres per minute) for each weir material. With this technique, water was discharged from a container with a known volume at a controlled rate and measuring the corresponding collection time, thereby determining the discharge (Q). To determine specific energy (E) for each test condition, the water depth flow upstream of the weir was measured with marks made along the flume. Standard open-channel flow equations incorporating kinetic and potential energy components were used to calculate specific energy.

Table 3.1: Discharge (Q) at Various Flow Rates for Each Material

Flow Rate (L/min)	Concrete (Q, L/s)	Plastic (Q, L/s)	Plywood (Q, L/s)
2	0.034	0.035	0.033
4	0.067	0.065	0.064
6	0.101	0.097	0.093
8	0.133	0.126	0.120
10	0.167	0.159	0.150

To assess the flow patterns, the experimental data was organised into tables and charts. Coefficients of discharge for each material were calculated and plotted against the corresponding flow rates. These graphs streamlined the identification of irregular flow patterns and how these might relate to material characteristics, such as surface roughness, structural rigidity, or deformation under pressure.

The quantitative analysis was complemented with qualitative assessments focusing on surface details and the clarity of the captured photos. While the clear photos provided sharpness to document the surface features, some images lacked this sharpness which was clearly not an issue with material functionality.

In parallel with the quantitative data, qualitative aspects of the materials under test were incorporated. The plastic weir showed noticeable deformation with increasing flow rates, the plywood experienced minor swelling due to moisture, and the concrete weir remained unchanged.

Subsequently, a comparative assessment of the collected data from the three materials was performed. In order to evaluate the effect of the chosen material on accuracy, the contours and trends of discharge and specific energy were evaluated. The results indicated that although the material type influenced the reproducibility of the experiments, particularly at high flow rates, a consistent weir geometry was more influential.

This way, the most critical conclusions related to the hydraulic performance of different materials used to construct a Crump weir were obtained in this round of data collection. Moreover, it demonstrated that certain materials, particularly plywood and plastic, can serve as beneficial substitutes for educational and experimental purposes, provided they are constructed and calibrated appropriately.

4. Results and Discussion

This section presents the results obtained from the constructive experimental evaluation of Crump type weirs made of concrete, plastic, and plywood. It can be deduced that the experimental results strongly supported the three objectives of the study. To begin with, the Crump weirs made from concrete, plastic, plywood and acrylic followed the required geometrical specifications. Secondly, the trends of discharge (Q) and specific energy (E) measurements for each weir material and their alignment with theoretical curve findings confirm that their hydraulic behaviour was homogeneous. Specific energy calculations as well as discharge measurements for various flow rates were empirically substantiated and examined. The relationship alongside structural observations regarding the condition of tested materials post experimentation demonstrates the impact of the properties of materials on their hydraulic performance, durability, and educational value. The findings were systematically presented based on the logical structure of testing, analysis, implications, and analysis. Also included were discussions regarding trade-offs between these three outlined parameters, accuracy, cost, and ease of use in regards to the use of alternate materials in instructional hydraulic labs at the technical and polytechnic levels.

4.1 Discharge and Specific Energy Trends

The structural and physical characteristics of each Crump weir material influenced the changes in discharge (Q) and specific energy (E) are clear from the experiments. Furthermore, the dataset suggests that the concrete, plastic, and plywood weirs all obeyed the specific energy and flow depth (y) relationship.

From the lowest to the highest discharge rates, measured values maintained alignment with theoretical expectations throughout the entire flow range. For example, all three weirs reached maximum specific energy of about 0.168 m at flow depth of 0.167 m at the peak flow rate of 10 L/min. This consistency was also observed in intermediate measurements; for all materials, E = 0.122 m at y = 0.12 m and E = 0.144 m at y = 0.143 m were constant.

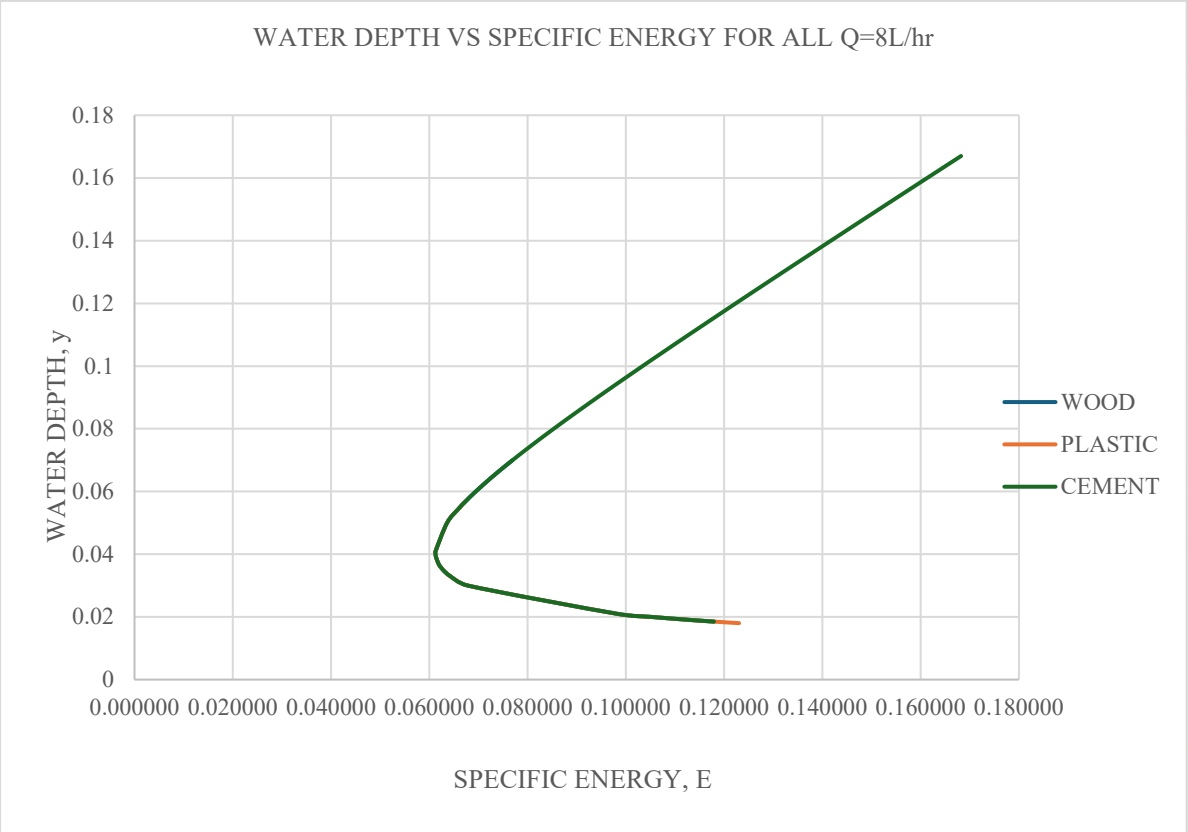


Figure 4.1: Specific Energy € vs Flow Rate for Cement, plastic and wood Crump Weir

The trend is more clearly visible in the plotted graph Figure 4.1 Water Depth vs Specific Energy for All Q = 8L/hr. The specific energy curves for wood, plastic, and concrete diverge and converge, suggesting the weirs made from different materials responded to the flow in a nearly identical hydrodynamic way, which is a sign they were manufactured to the same geometry and retained their shape. The curves also rise gradually, indicating that flow depth and specific energy are directly proportional, which is expected in open channels for subcritical flow (Chow, 1959). The data alignment remained unchanged despite some minor differences like the aforementioned rounding that appear at higher flow rates.

The second research objective was to study the differences in the hydraulic behaviour of Crump weirs made from different materials and test the accuracy of their predicted theoretical behaviour. This outcome also supports the controlled geometric approach as a means of material isolation in testing the effects of different materials. Also, the latter supports the third objective of the study which concluded that lower cost materials, like plastic and plywood, can replace higher cost materials, like concrete, provided the geometric shape of the weir is kept consistent.

The dataset along with Figure 4.2 shows that specific energy (E) and flow depth (y) were nearly constant for all tested variables and conditions. For all tested materials, for example, E reached a maximum flow rate of 0.123 m with a flow depth of 0.018 m. These observed consistencies further confirm the robustness of the V/t measurement method and the reproducibility of the study's experimental design. This prevailing agreement indicates that the hydraulic teaching flumes can be manufactured with different materials, which greatly reduces costs while maintaining measurement accuracy and the quality of the instruction (Crump and Burkitt, 1952; Oertel and Shen, 2022).

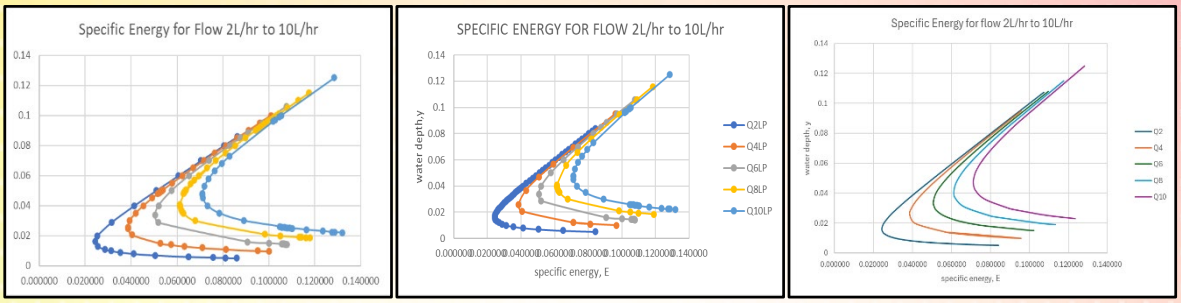


Figure 4.2: Specific Energy (E) vs Flow Rate for Cement, plastic and wood Crump Weir for each flow rate

4.2 Structural Observations

The concrete and plastic components of the testing apparatus behaved differently under the influence of continually flowing water. There was no observable surface damage, cracking, or water ingress, and the concrete weir did not deform throughout the tests. This confirmed the concrete's durability and suitability for thermal and mechanical stresses, frequent use, and repetitive motion in an educational laboratory setting. In contrast, the plastic weir exhibited significant bowing and cracks at the edges at flow rates of 8 to 10 L/min. Its lightweight and easy-to-handle design limited its use in high-flow sustained experiments, proving the need for structural reinforcements to maintain flow measurement accuracy. Prolonged water exposure warped the plywood, increasing its roughness. While some swelling of the surface did occur, the overall shape was maintained sufficiently to enable functional hydrodynamic behaviour. This suggests that while less robust than concrete, plywood could serve as an economical alternative provided there is proper maintenance and regular replacement schedule.

Table 4.1: Material Structural Performance Summary

Material	Surface Observation	Deformation	Water Interaction
Concrete	Smooth and rigid	None	Negligible absorption
Plastic	Smooth, slightly bowed at high flow rates	Minor at 10 L/min	No absorption; slight flexing
Plywood	Surface roughness increased post-use	Slight warping	Minor swelling observed

This table captures the behaviour of each material and also reinforces the qualitative observations. As a whole, plywood had an appropriate compromise for budget-sensitive applications, plastic had simple handling, but low durability at higher flows, and concrete had plastic with the highest structural strength. These noted remarks further validate the efficiency of inexpensive alternatives when strategically and moderately placed under flow stress.

4.3 Educational Implications

Their study on Crump weirs made of concrete and plywood showed how these materials can readily serve as low-cost weirs while still providing accurate measurements for hydraulic experiments in schools and technical-vocational education institutes. Plywood meets measurement precision; plywood weir construction can yield accurate geometry while being affordable.

Plastic is still suitable for portable and lightweight teaching demonstration setups on free-standing portable devices, but when planning stationary equipment for long-term

laboratory use, it should be designed for stationary use, taking into consideration plastic's tendency to deform with constant exposure to high flow conditions.

The weight of concrete makes it inflexible for laboratory layouts and different arrangements, but for dependable hydraulic experiments, it is still the best material to use. The reliability of the study reinforced the proposed concept of material selection, which considers the frequency of use, limited budget, and the nature of education. With this in mind, the study serves as a stimulus for teachers and laboratory planners to use inexpensive and readily available materials without sacrificing measurement precision and the quality of teaching for essential hydraulic concepts.

5. Conclusions

This research assessed the hydraulic performance of Crump weirs made from plywood, plastic, and concrete using a non-calibrated laboratory flume setup. The results showed that concrete consistently provided the best structural stability and accuracy at all flow rates tested. However, both plywood and plastic weirs performed adequately within reasonable functional limits. For resource-constrained institutions, plywood performed the best as a substitute and was much cheaper while still providing good accuracy as long as shape maintenance and surface wear were monitored. Although plastic was easy to make and lightweight, it had structural shortcomings at higher flow rates because of some gentle warping, indicating it is better for demonstration purposes than long-term applications.

As indicated earlier, low-cost resources such as plastic and plywood are applicable substitutes for concrete in the construction of weirs in hydraulic teaching laboratories. This has significance, especially in technical and vocational institutions where funding is scarce. Framing the conversation in this context also brings up the case of finding the right balance between the lifespan of the material, its cost, accuracy, and precision in the case of the material selection in educational lab settings. The careful use of such alternative materials helps enhance the availability of practical hydraulic experiments and fosters economical and sustainable approaches.

Further research evaluating the application of resin coatings and the use of waterproof sealants on plywood to reduce surface roughness and swelling over time would be beneficial to the study of material viability. The implementation of rigid internal framing in plastic weirs would help mitigate flow-deformation issues at high flow rates. These adaptations would enhance the inexpensive weir models and extend their use in educational environments.

There are also opportunities for research exploring the designs of hybrid material weirs that integrate the various beneficial aspects of different materials and study their long-term durability with cyclic flow testing. These approaches would enhance the teaching of fluid mechanics by diversifying pedagogical approaches.

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KEBERKESANAN KURSUS PEMBELAJARAN SEPANJANG HAYAT 'LINUX UBUNTU UNTUK SEMUA' DI POLITEKNIK SULTAN ABDUL HALIM MU'ADZAM SHAH

Mazuin Binti Stapah @ Salleh[1*], Azrul Hisham Bin Shuib[2], Azfariza Binti Azizi[3]

[1,3]Jabatan Teknologi Maklumat & Komunikasi, Politeknik Sultan Abdul Halim Mu'adzam Shah, 06000 Jitra, Kedah

[2]Unit Pembelajaran Sepanjang Hayat, Kolej Komuniti Arau, 02600 Arau, Perlis

*mazuinss@polimas.edu.my, azrul.hisham@kkarau.edu.my, azfariza@polimas.edu.my

Abstract

The "Linux Ubuntu for All" course is an initiative by the Department of Information and Communication Technology (JTMK) and the Lifelong Learning Unit, Centre for Continuing Education (PSH, ULPL) at Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS), aimed at enhancing digital skills among the local community. This study was conducted to evaluate the effectiveness of the course in terms of participants' knowledge improvement and satisfaction with the course implementation. A total of 28 participants aged between 18 and 25 years attended the one-day course held in Computer Lab 4 and completed a self-administered questionnaire before and after the session. The research instrument included self-assessment items measuring knowledge and skills related to Linux using a 5-point Likert scale (pre- and post-course), along with items assessing course satisfaction. Findings indicated an increase in the average knowledge score from 2.8 (SD = 1.27) before the course to 3.69 (SD = 0.95) after the course. Participants also gave highly positive feedback on the course implementation, with satisfaction items recording an average score of 4.5. In conclusion, the "Linux Ubuntu for All" course was proven effective in improving participants' basic knowledge of Linux and achieved a high level of satisfaction. This study supports the role of lifelong learning (PSH) as an effective platform to empower digital literacy among youth, in line with national aspirations to promote lifelong learning participation across society.

Keywords: *Lifelong Learning (PSH); Linux Ubuntu; Course Effectiveness; Course Satisfaction*

Abstrak

Kursus 'Linux Ubuntu Untuk Semua' merupakan inisiatif Jabatan Teknologi Maklumat dan Komunikasi (JTMK) dan Unit Pembelajaran Sepanjang Hayat, Unit Pendidikan dan Lanjutan (PSH, ULPL) di Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS) bagi meningkatkan kemahiran teknologi maklumat dalam kalangan komuniti. Kajian ini bertujuan menilai keberkesanan kursus tersebut dari segi peningkatan pengetahuan peserta dan tahap kepuasan mereka terhadap pelaksanaan kursus. Seramai 28 orang peserta berumur antara 18 hingga 25 tahun telah mengikuti kursus selama satu hari di Makmal Komputer 4 dan telah melengkapkan soal selidik sebelum dan selepas kursus. Instrumen kajian merangkumi penilaian kendiri tahap pengetahuan dan kemahiran berkaitan Linux menggunakan Skala Likert 1-5 (sebelum dan selepas kursus) serta soal selidik kepuasan kursus. Dapatan kajian menunjukkan berlaku peningkatan skor purata pengetahuan daripada 2.8 (SD = 1.27) sebelum kursus kepada 3.69 (SD = 0.95) selepas kursus. Peserta turut memberikan maklumbalas yang sangat positif terhadap pelaksanaan kursus, di mana item kepuasan kursus mencatat skor purata 4.5. Kesimpulannya, kursus 'Linux Ubuntu Untuk Semua' terbukti berkesan dalam meningkatkan pengetahuan asas Linux dan mencapai tahap kepuasan yang tinggi dalam kalangan peserta. Kajian ini menyokong peranan PSH sebagai medium berkesan untuk memperkasa pengetahuan teknologi maklumat dan komunikasi (ICT) belia, sejajar dengan aspirasi negara untuk meningkatkan penglibatan pembelajaran sepanjang hayat dalam kalangan masyarakat.

Kata kunci: *Pembelajaran Sepanjang Hayat (PSH); Linux Ubuntu; Keberkesanan Kursus, Kepuasan Kursus*

1.0 PENGENALAN

Pembelajaran Sepanjang Hayat (PSH) merujuk kepada proses pembelajaran berterusan sepanjang hayat bagi seseorang individu, merangkumi pendidikan secara formal, tidak formal dan juga informal (Safar, 2024). Inisiatif pelaksanaan kursus PSH diakui membawa banyak manfaat kerana ia dapat memperkasakan ilmu pengetahuan, meningkatkan kemahiran pekerjaan dan memperbaiki kualiti hidup individu yang terlibat (Bahari, 2025). Sejajar dengan kepentingan PSH ini, Kerajaan Malaysia telah melaksanakan Pelan Induk PSH 2011-2020 dan kemudiannya menggubal Pelan Induk PSH Malaysia 2021 bagi terus menggalakkan penyertaan pembelajaran sepanjang hayat secara lebih meluas dalam kalangan rakyat (Safar, 2024). Institusi pendidikan tinggi seperti politeknik dan kolej komuniti memainkan peranan sebagai pemudah cara dengan menyediakan pelbagai peluang latihan PSH kepada komuniti setempat, disokong oleh tenaga pengajar berkemahiran serta prasarana yang bersesuaian (WilayahKu, 2021). Oleh itu, dalam era kemajuan teknologi yang pesat masa kini, komuniti disarankan merebut peluang pembelajaran yang tersedia untuk meningkatkan ilmu dan kemahiran mereka terutamanya bagi mendepani perkembangan bidang teknologi terkini (Ong, 2024).

Politeknik Sultan Abdul Halim Mu'adzam Shah (POLIMAS) melalui JTMK dan Unit PSH, ULPL menawarkan pelbagai kursus jangka pendek kepada komuniti bagi menyahut dasar kerajaan. Salah satu kursus yang telah dilaksanakan ialah 'Linux Ubuntu Untuk Semua'.

Kursus ini memfokuskan pendedahan kepada sistem operasi sumber terbuka (*open-source operating system*) Linux Ubuntu. Ini kerana kebanyakan pengguna komputer awam lebih biasa dengan sistem operasi komersial contohnya Windows, manakala pengetahuan mengenai Linux masih terhad. Linux Ubuntu dipilih kerana ia mesra pengguna, percuma dan sesuai untuk pelbagai kegunaan termasuk untuk aktiviti pembelajaran dan pekerjaan.

Melalui kursus ini, peserta didedahkan kepada asas-asas penggunaan Linux merangkumi pemahaman konsep sistem operasi Linux, perbezaan Linux dengan Windows, kemahiran praktikal seperti pemasangan perisian, penggunaan *command line*, pengurusan fail, dan penyelesaian masalah asas dalam persekitaran Linux.

Kursus PSH 'Linux Ubuntu Untuk Semua' dilaksanakan secara intensif selama satu hari (6 jam) di Makmal Komputer 4, POLIMAS. Seorang pensyarah JTMK POLIMAS yang berpengalaman dalam sistem Linux bertindak sebagai tenaga pengajar dengan dibantu oleh seorang fasilitator. Kursus ini disasarkan kepada golongan belia dan dewasa muda.

Kandungan kursus dimulakan dengan sesi teori secara ringkas yang merangkumi pengenalan kepada sistem operasi Linux, perbandingan asas antara Linux dan Windows, serta kelebihan menggunakan perisian sumber terbuka. Seterusnya peserta menjalankan amali (*hands-on*) pemasangan perisian, penggunaan arahan asas melalui terminal, penyambungan peranti luaran, pengurusan fail dan *folder*, serta penyelesaian masalah teknikal mudah seperti isu sambungan internet dan akses fail.

Tenaga pengajar telah melakukan demonstrasi terlebih dahulu sebelum peserta diminta untuk melaksanakan tugasan amali secara individu atau berkumpulan. Kursus telah diakhiri dengan sesi soal jawab bagi mengukuhkan kefahaman para peserta.

Kursus *"Linux Ubuntu Untuk Semua"* dilihat sebagai satu inisiatif yang selaras dengan perkembangan semasa dan keperluan peningkatan kemahiran teknologi maklumat dan komunikasi (ICT) dalam kalangan belia. Justeru, kajian ini dijalankan bagi menilai keberkesanan kursus tersebut dari aspek peningkatan pengetahuan dan kemahiran peserta serta

tahap kepuasan mereka terhadap pelaksanaan kursus. Kajian ini bukan sahaja menilai kesan segera kursus, tetapi juga bertujuan menyumbang kepada penambahbaikan pelaksanaan program PSH di masa hadapan, khususnya dalam bidang teknologi maklumat.

Kajian-kajian terkini turut menyokong keberkesanan program PSH dalam bidang ICT. Sebagai contoh, kajian oleh Husin et al. (2024) di Kolej Komuniti Pasir Mas mendapati program PSH berteraskan Revolusi Industri 4.0 berjaya mencapai tahap motivasi dan kepuasan peserta yang tinggi kerana kandungan kursus dianggap relevan dengan keperluan semasa. Sementara itu, kajian oleh Norlia et al. (2022) di Kolej Komuniti Nibong Tebal turut melaporkan tahap keberkesanan dan kepuasan yang sangat tinggi dalam kalangan peserta terhadap kursus ICT yang diikuti. Berdasarkan penemuan kajian terdahulu ini, pengkaji menjangkakan bahawa kursus *"Linux Ubuntu Untuk Semua"* juga akan menunjukkan keberkesanan yang positif dari segi peningkatan pengetahuan serta kepuasan peserta, selaras dengan trend keberkesanan program PSH ICT yang telah dilaporkan di institusi lain.

2.0 OBJEKTIF KAJIAN

Kajian ini dijalankan dengan tiga objektif utama seperti berikut:

1. Menilai peningkatan pengetahuan dan kemahiran peserta tentang sistem operasi Linux Ubuntu dengan membandingkan tahap pengetahuan sebelum dan selepas menyertai kursus.
2. Menilai tahap kepuasan peserta terhadap pelaksanaan kursus dari aspek kandungan, penyampaian pengajar, kaedah pengajaran secara amali, tempoh masa serta bahan bantu kursus.
3. Mencadangkan penambahbaikan dan kajian lanjutan berdasarkan dapatan kajian bagi memperkukuhkan lagi keberkesanan kursus pada masa akan datang serta mengembangkan lagi program PSH seumpamanya.

3.0 METODOLOGI KAJIAN

Bahagian ini membincangkan berkenaan reka bentuk kajian, responden kajian, instrumen kajian dan kaedah analisis data.

3.1 REKA BENTUK KAJIAN

Kajian ini menggunakan reka bentuk kajian deskriptif kuantitatif dengan pendekatan pra dan pasca ujian tanpa kumpulan kawalan (one-group pretest-posttest design) melalui edaran borang soal selidik kepada peserta kursus. Reka bentuk ini sesuai digunakan dalam penilaian latihan jangka pendek kerana ia membolehkan penyelidik mengukur perubahan atau peningkatan hasil pembelajaran selepas intervensi dijalankan tanpa memerlukan kumpulan perbandingan (Creswell et al., 2018; Fraenkel et al., 2012).

Proses pengumpulan data dijalankan sejurus selepas tamat kursus dengan menggunakan kaedah penilaian retrospektif di mana peserta diminta menilai tahap pengetahuan mereka sebelum kursus dan selepas kursus dalam borang yang sama berdasarkan ingatan dan refleksi kendiri terhadap pembelajaran yang telah diperoleh. Pendekatan retrospektif ini dipilih bagi memastikan konsistensi penilaian oleh peserta dan mengelakkan bias perbezaan tafsiran skala sebelum dan selepas mengikuti kursus supaya impak program dapat dinilai dengan lebih tepat (Pratt et al., 2000). Peserta dapat membuat refleksi kendiri yang lebih tepat selepas memperoleh kefahaman sebenar tentang kandungan kursus.

3.2 SAMPEL KAJIAN

Seramai 28 orang peserta kursus 'Linux Ubuntu Untuk Semua' telah terlibat dalam kajian ini. Semua peserta telah mengikuti kursus secara bersemuka selama satu hari dan diminta melengkapkan borang soal selidik pada akhir sesi kursus. Pemilihan responden dibuat secara persampelan bertujuan (purposive sampling), iaitu melibatkan semua peserta yang hadir dan bersetuju memberikan maklum balas. Kajian ini memberi tumpuan kepada peserta yang berada dalam lingkungan umur 18 hingga 25 tahun, yang merupakan golongan sasar utama program PSH dalam bidang teknologi maklumat.

3.3 INSTRUMEN KAJIAN

Instrumen yang digunakan dalam kajian ini ialah borang soal selidik dan diedarkan secara dalam talian melalui platform Google Forms. Soal selidik ini dibahagikan kepada lima bahagian utama:

i. Bahagian A: Maklumat demografi peserta yang melibatkan jantina, umur, status pekerjaan serta pengalaman terdahulu mengikuti kursus berkaitan ICT.
ii. Bahagian B: Mengandungi 10 item penilaian kendiri tahap pengetahuan dan kemahiran berkaitan Linux sebelum kursus menggunakan Skala Likert 1 hingga 5 (1 = Sangat Tidak Setuju, 5 = Sangat Setuju).
iii. Bahagian C: Penilaian kendiri tahap pengetahuan dan kemahiran selepas kursus dengan menggunakan item yang sama seperti Bahagian B.
iv. Bahagian D: Penilaian kepuasan peserta terhadap pelaksanaan kursus yang terdiri daripada lima item pernyataan melibatkan aspek tempoh kursus, kaedah penyampaian fasilitator, kualiti bahan dan modul, keberkesanan pendekatan hands-on serta minat untuk mengikuti kursus lanjutan. Penilaian bahagian ketiga turut menggunakan Skala Likert 5 mata.
v. Bahagian E: Terdiri daripada dua soalan terbuka untuk mendapatkan maklum balas kualitatif daripada peserta berkenaan aspek yang paling disukai dan cadangan penambahbaikan daripada peserta. Maklum balas ini memberikan input tambahan bagi menyokong dapatan kuantitatif.

Soal selidik ini tidak melalui proses kajian rintis secara formal. Namun begitu, bagi menjamin kesesuaian kandungan dan kefahaman bahasa, semua item telah disemak oleh dua orang pensyarah berpengalaman dalam bidang teknologi maklumat dan penyelidikan pendidikan. Pemeriksaan ini meliputi kejelasan pernyataan, kesesuaian dengan tahap peserta, serta keselarasan dengan objektif kajian.

Pengiraan pekali kebolehpercayaan seperti Cronbach's Alpha tidak dilakukan memandangkan soal selidik ini tidak direka bentuk untuk mengukur konstruk psikometrik tunggal. Item yang digunakan dalam Bahagian B dan C dalam mengukur pengetahuan atau kemahiran spesifik yang berbeza. Item-item ini berfungsi sebagai indikator individu bagi menilai perubahan pengetahuan dan kemahiran peserta secara deskriptif melalui pendekatan pra dan pasca (pre-post self-assessment). Dalam kajian impak program jangka pendek seperti ini, pendekatan tersebut dianggap memadai untuk menilai keberkesanan kursus (Yunos et al., 2023).

3.4 KAEDAH ANALISIS DATA

Data kuantitatif yang diperoleh melalui borang soal selidik Google Forms telah dianalisis menggunakan perisian Microsoft Excel. Bagi setiap item yang menggunakan skala Likert, nilai skor min dan sisihan piawai telah dikira bagi dua peringkat iaitu sebelum dan selepas kursus. Perbezaan antara skor min bagi setiap item dianalisis untuk mengenal pasti sama ada berlaku peningkatan atau penurunan tahap pengetahuan dan kemahiran peserta. Fokus utama analisis kuantitatif adalah terhadap 10 item berkaitan pengetahuan sistem Linux bagi menilai keberkesanan pelaksanaan kursus.

Selain itu, skor min bagi 5 item yang menilai tahap kepuasan peserta selepas kursus juga dikira bagi memperoleh gambaran umum terhadap persepsi peserta terhadap kualiti kursus.

Penyelidik menggunakan kaedah interpretasi skor min yang telah digunakan secara meluas dalam kajian sosial dan pendidikan di Malaysia, iaitu pembahagian julat seperti Jadual 1. Tafsiran ini berasaskan rujukan daripada kajian tempatan seperti yang dinyatakan oleh Yunos et al. (2023), serta didukung oleh pendekatan yang digunakan dalam pelbagai kajian lain seperti Mohamad et al. (2023) dan Ismail et al. (2022).

Jadual 1: Interpretasi Skor Min

BIL	SKOR MIN	INTERPRETASI SKOR MIN
1.	1.00–2.33	Rendah
2.	2.34–3.66	Sederhana
3.	3.67–5.00	Tinggi

Manakala data kualitatif bagi kajian ini diperoleh melalui dua soalan terbuka yang disertakan di akhir soal selidik. Ia bertujuan mendapatkan pandangan peserta terhadap aspek terbaik kursus serta cadangan penambahbaikan. Analisis dilakukan menggunakan kaedah analisis tematik secara ringkas, iaitu dengan membaca respons peserta secara teliti dan mengenal pasti isi utama yang berulang. Isi penting ini kemudiannya dikumpulkan dan dirumuskan kepada beberapa tema utama seperti kaedah pengajaran, kandungan kursus, cadangan teknikal, dan aspek berkaitan lain.

Pendekatan tematik ringkas ini membolehkan penyelidik mengenal pasti maklum balas utama secara sistematik tanpa menggunakan kaedah analisis kualitatif mendalam. Dapatan daripada analisis ini kemudiannya digunakan untuk menyokong dan memperkukuh interpretasi hasil kajian kuantitatif dalam bahagian perbincangan.

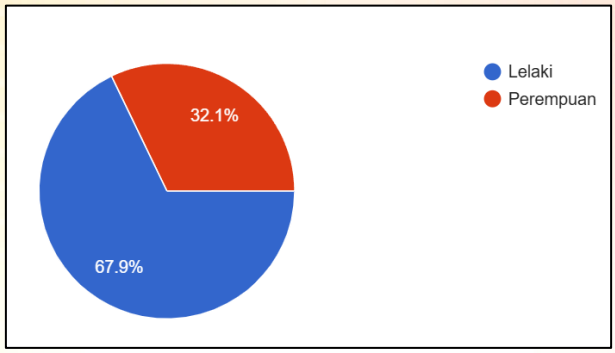
4.0 DAPATAN KAJIAN

Bahagian ini membincangkan berkenaan demografi peserta, keberkesanan kursus dari aspek peningkatan pengetahuan, kepuasan terhadap pelaksanaan kursus dan dapatan kualitatif.

4.1 DEMOGRAFI PESERT

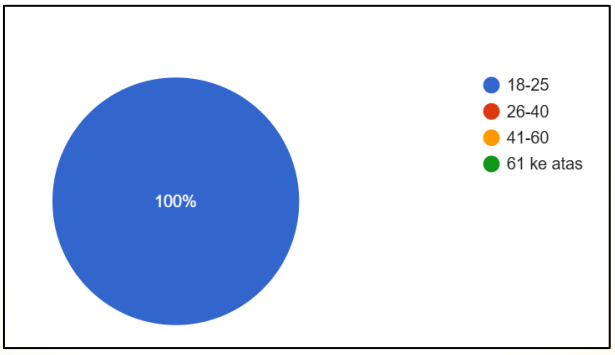
Berdasarkan Bahagian A soal selidik (maklumat demografi), 67.9% daripada keseluruhan peserta kursus adalah lelaki, manakala 32.1% adalah perempuan. Carta pai dalam Rajah 1 tersebut jelas memperlihatkan bahawa kursus ini lebih banyak disertai oleh peserta

lelaki berbanding perempuan. Keadaan ini mungkin mencerminkan kecenderungan golongan lelaki terhadap kursus berkaitan sistem operasi dan teknologi maklumat, yang secara tradisinya lebih mendapat sambutan dalam kalangan pelajar lelaki di institusi Pendidikan dan Latihan Teknikal dan Vokasional (TVET) dan politeknik (Sidek, R., & Ismail, M. (2021)



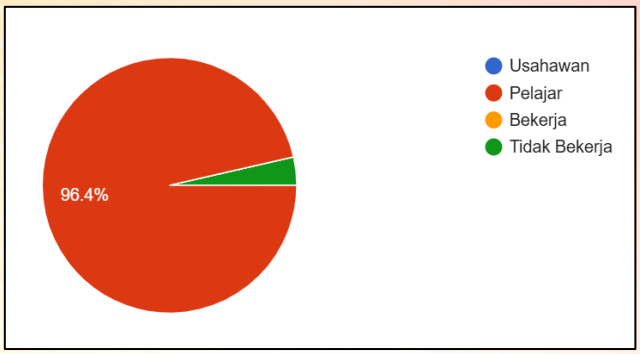
Rajah 1: Graf Jantina Peserta

Manakala Rajah 2 menunjukkan bahawa 100% peserta kursus terdiri daripada individu berumur antara 18 hingga 25 tahun iaitu golongan belia yang lazimnya merupakan pelajar institusi pengajian tinggi. Kehadiran sepenuhnya daripada kumpulan umur ini mencerminkan kecenderungan generasi muda untuk mengikuti kursus yang berkaitan dengan teknologi maklumat termasuk sistem operasi sumber terbuka seperti Linux. Ini juga jelas menunjukkan bahawa kursus pendek PSH seperti ini mampu menarik minat pelajar dalam kalangan generasi digital yang ingin menambah kemahiran teknikal di luar kurikulum akademik formal.



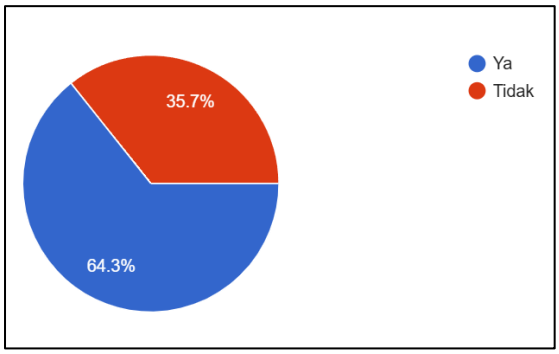
Rajah 2: Graf Umur Peserta

Rajah 3 pula menunjukkan sebanyak 96.4% peserta kursus merupakan pelajar manakala selebihnya terdiri daripada peserta yang tidak bekerja. Ini menunjukkan bahawa penyertaan kursus ini didominasi oleh golongan pelajar institusi pengajian tinggi yang berkemungkinan berminat untuk menambah kemahiran tambahan dalam bidang teknologi maklumat sebagai persediaan menghadapi dunia pekerjaan. Penyertaan tinggi dalam kalangan pelajar juga mencerminkan kesesuaian kandungan kursus dengan keperluan dan minat generasi muda yang celik teknologi. Kursus seperti ini boleh dijadikan platform pembelajaran tidak formal yang menyokong agenda pembelajaran sepanjang hayat dalam kalangan pelajar TVET.



Rajah 3: Graf Status Peserta

Seterusnya Rajah 4 menunjukkan bahawa sebanyak 64.3% peserta pernah mengikuti kursus berasaskan teknologi maklumat sebelum ini. Ini menunjukkan bahawa majoriti peserta telah mempunyai pendedahan awal terhadap bidang teknologi sama ada melalui kursus formal atau tidak formal. Walau bagaimanapun kehadiran peserta yang belum pernah mengikuti sebarang kursus seumpama ini juga menunjukkan bahawa kursus ini berjaya menarik minat peserta dengan latar belakang pengetahuan yang pelbagai. Ini penting kerana ia menunjukkan kursus ini sesuai untuk pelajar yang baru berjinak-jinak dengan ICT serta mereka yang ingin menambah ilmu sedia ada dalam bidang teknologi sumber terbuka.



Rajah 4: Pengalaman Mengikuti Kursus Berasaskan Teknologi Maklumat

4.2 KEBERKESANAN KURSUS DARI ASPEK PENINGKATAN PENGETAHUAN

Fokus utama kajian ini adalah untuk menilai keberkesanan kursus dari aspek peningkatan tahap pengetahuan dan kemahiran peserta berkaitan sistem pengoperasian Linux. Penilaian ini dibuat berdasarkan perbandingan skor min bagi 10 item pengetahuan sebelum dan selepas kursus seperti yang ditunjukkan dalam Jadual 2.

Jadual 2: Min dan Sisihan Piawai Setiap Item Aspek Peningkatan Pengetahuan

BIL	ITEM	MIN SEBELUM KURSUS	SISIHAN PIAWAI SEBELUM KURSUS	MIN SELEPAS KURSUS	SISIHAN PIAWAI SELEPAS KURSUS
1.	Saya tahu apakah itu sistem operasi Linux.	3.32	1.28	4.00	0.76
2.	Saya tahu perbezaan asas antara Windows dan Linux.	3.54	1.24	4.04	0.78

3.	Saya pernah menggunakan sistem operasi Linux sebelum ini.	2.21	1.29	3.21	1.26
4.	Saya tahu bagaimana untuk memasang perisian dalam sistem Linux.	2.64	1.26	3.43	0.90
5.	Saya tahu bagaimana menggunakan *command line* asas dalam Linux.	2.61	1.21	3.71	0.96
6.	Saya tahu bagaimana menyambung peranti (*printer*, *USB*, dsb) dalam Linux.	2.57	1.21	3.54	1.02
7.	Saya boleh menyelesaikan masalah asas ketika menggunakan Linux.	2.39	1.23	3.50	0.91
8.	Saya boleh mengurus fail dan *folder* dalam sistem Linux Ubuntu.	2.71	1.33	3.89	0.98
9.	Saya tahu kelebihan menggunakan sistem Linux untuk kegunaan peribadi atau komuniti.	3.00	1.34	3.89	0.94
10.	Saya yakin boleh membantu orang lain menggunakan Linux selepas kursus ini.	3.00	1.28	3.71	1.03

Secara keseluruhan, dapatan menunjukkan bahawa semua item mencatatkan peningkatan skor min selepas peserta mengikuti kursus. Peningkatan ini mencerminkan berlakunya peningkatan dalam pengetahuan dan kemahiran peserta berkaitan Linux selepas mengikuti kursus. Hasil ini memberikan indikasi bahawa kursus yang dilaksanakan telah mencapai objektif pembelajaran yang ditetapkan khususnya dalam memperkenalkan asas penggunaan Linux secara teori dan praktikal.

Secara keseluruhan, skor min sebelum kursus berada dalam lingkungan 2.21 hingga 3.54, menunjukkan tahap keyakinan yang sederhana atau rendah terhadap pengetahuan dan kemahiran berkaitan Linux.

Item 3 berkaitan pengalaman menggunakan Linux mencatatkan skor min paling rendah iaitu 2.21, Seramai 17 orang daripada 28 orang peserta (61%) telah memilih respon “Tidak Setuju” atau “Sangat Tidak Setuju” terhadap pernyataan “Saya pernah menggunakan sistem operasi Linux sebelum ini” semasa penilaian sebelum kursus. Walaupun kebanyakan peserta merupakan pelajar institusi pengajian tinggi dan didapati celik komputer, majoriti peserta tidak pernah menggunakan Linux sebelum ini. Oleh itu, pelaksanaan kursus ‘Linux Ubuntu Untuk Semua’ adalah sangat relevan dan signifikan dalam memberikan pendedahan awal kepada peserta terhadap alternatif sistem operasi sumber terbuka seperti Linux, selaras dengan keperluan memperkasa kemahiran teknologi dalam kalangan generasi muda.

Begitu juga, kemahiran teknikal seperti memasang perisian, penggunaan *command line*, penyambungan peranti, penyelesaian masalah dan pengurusan fail turut mencatatkan skor di bawah 3.0. Ini memperlihatkan kekurangan pengalaman dalam aspek praktikal.

Sebaliknya, pengetahuan konseptual asas seperti item 1 dan 2 mencatat skor min sedikit lebih tinggi iaitu 3.32 dan 3.54. Ini berkemungkinan disebabkan pendedahan awal melalui pembacaan atau pengalaman tidak formal.

Manakala semua item menunjukkan peningkatan skor min yang ketara selepas kursus, iaitu dalam lingkungan 3.21 hingga 4.04. Peningkatan tertinggi dicatatkan bagi item kemahiran praktikal, contohnya kemahiran menggunakan *command line* meningkat daripada 2.61 kepada 3.71, manakala kemahiran menyelesaikan masalah asas meningkat daripada 2.39 kepada 3.50. Begitu juga, pengurusan fail dan *folder* mencatatkan peningkatan tertinggi iaitu daripada 2.71 kepada 3.89. Peningkatan ini mencerminkan impak langsung daripada pendekatan *hands-on* yang dilaksanakan semasa sesi latihan.

Pengetahuan berkaitan kelebihan Linux turut meningkat daripada skor min 3.0 kepada 3.89. Ini menunjukkan peserta bukan sahaja memperoleh kemahiran praktikal, malah turut memahami kelebihan sistem operasi sumber terbuka ini dari segi kos, keselamatan dan fleksibiliti. Keyakinan peserta untuk membantu orang lain turut meningkat daripada min 3.0 kepada 3.71. Ini menggambarkan peningkatan kepercayaan diri peserta terhadap penguasaan ilmu yang diperoleh. Walau bagaimanapun, skor ini masih belum mencapai tahap maksimum, menunjukkan perlunya pendedahan lanjutan bagi memantapkan lagi kemahiran tersebut.

Item berkaitan pengetahuan asas juga menunjukkan peningkatan iaitu kepada skor min 4.0 bagi kedua-dua item "tahu apa itu Linux" dan "tahu perbezaan antara Linux dan Windows". Hal ini menunjukkan tahap kefahaman yang jelas dalam kalangan peserta selepas kursus.

Jadual 3: Min dan Sisihan Piawai Keseluruhan Item Aspek Peningkatan Pengetahuan

MIN SEBELUM KURSUS	SISIHAN PIAWAI SEBELUM KURSUS	MIN SELEPAS KURSUS	SISIHAN PIAWAI SELEPAS KURSUS
2.8	1.27	3.69	0.95

Jadual 3 menunjukkan bahawa skor min keseluruhan pengetahuan meningkat daripada 2.8 (sebelum kursus) kepada 3.69 (selepas kursus) dengan sisihan piawai 0.95. Ini membuktikan keberkesanan kursus jangka pendek ini dalam meningkatkan pengetahuan dan kemahiran asas peserta terhadap Linux. Dapatan ini sejajar dengan penemuan kajian terdahulu oleh Hashim et al. (2023) bahawa program jangka pendek untuk pelajar tahfiz di Kolej Komuniti Pasir Gudang didapati memberi impak positif terhadap peningkatan ilmu pengetahuan dan kemahiran peserta. Kajian ini turut mengesahkan bahawa pendekatan pengajaran praktikal secara *hands-on* mampu meningkatkan keyakinan peserta untuk mengaplikasikan ilmu yang diperoleh dalam konteks sebenar.

4.3 KEPUASAN TERHADAP PELAKSANAAN KURSUS

Secara keseluruhan, tahap kepuasan peserta terhadap pelaksanaan kursus adalah sangat memberangsangkan. Lima item utama yang dinilai dalam soal selidik kepuasan selepas kursus mencatatkan skor min yang tinggi iaitu antara 4.29 hingga 4.61 daripada skala 5.

Jadual 4: Min Item Kepuasan Pelaksanaan Kursus

BIL	ITEM	MIN
1.	Tempoh masa kursus adalah mencukupi.	4.29

2.	Fasilitator menyampaikan kursus dengan jelas dan berkesan.	4.57
3.	Bahan bantu dan modul sangat membantu.	4.61
4.	Kaedah hands-on sangat berkesan.	4.50
5.	Saya ingin mengikuti kursus seumpama ini lagi.	4.46
PURATA MIN KESELURUHAN		4.49

Peserta sangat bersetuju bahawa tenaga pengajar berjaya menyampaikan kandungan kursus dengan jelas dan berkesan dengan skor min 4.57. Manakala bahan bantu dan modul yang disediakan pula amat membantu pemahaman mereka dengan skor min 4.61. Selain itu, kaedah pengajaran secara amali (hands-on) juga dinilai sangat berkesan oleh peserta kerana mencatat skor min 4.50. Dapatan ini membuktikan pendekatan secara amali sangat sesuai digunakan dalam kursus-kursus yang berasaskan kemahiran.

Sementara itu, item "tempoh masa kursus adalah mencukupi" mencatatkan skor min 4.29, iaitu paling rendah dalam kalangan lima item kepuasan. Namun begitu skor ini masih menunjukkan bahawa majoriti peserta berpuas hati dengan tempoh masa yang diperuntukkan. Dapatan ini juga selari dengan kajian Yunos et al. (2023) di Kolej Komuniti Bandar Darulaman yang melaporkan bahawa peserta kursus Adobe Illustrator selama satu hari (6 jam) berpuas hati dengan pelaksanaan program termasuk dari segi tempoh masa yang dianggap sesuai dan mencukupi. Penilaian dalam kajian tersebut menunjukkan bahawa peserta menilai tempoh kursus yang ditetapkan dapat menampung keperluan pembelajaran dengan baik tanpa membebankan peserta. Hal ini juga disokong oleh hasil kajian terdahulu oleh Salim et al. (2014) yang melaporkan bahawa peserta kursus pendek ICT di Kolej Komuniti Bukit Beruang berpuas hati dengan tempoh masa kursus sekitar lima jam memandangkan kandungan yang disampaikan adalah mudah difahami. Secara keseluruhannya tempoh masa sekitar satu hari masih dianggap praktikal dan sesuai untuk pelaksanaan kursus kemahiran asas seperti ini dengan syarat pengisian disusun dengan baik dan disampaikan secara berkesan.

Seterusnya hampir semua peserta menyatakan minat untuk mengikuti kursus seumpama ini lagi pada masa akan datang dengan skor min 4.46. Ini menunjukkan bahawa pengalaman yang dilalui adalah positif dan mendorong minat mereka untuk terus belajar.

Secara keseluruhannya hasil kajian ini menunjukkan bahawa kursus telah dilaksanakan dengan baik dari aspek penyampaian, kandungan serta pendekatan pengajaran dan berjaya memenuhi jangkaan peserta.

4.4 DAPATAN KUALITATIF

Dapatan kualitatif daripada soalan terbuka "apakah aspek kursus ini yang paling anda suka?" menunjukkan bahawa peserta memberikan maklum balas yang positif terhadap pelaksanaan kursus. Beberapa tema utama hasil daripada analisis kandungan respons peserta telah dikenal pasti seperti berikut:

(i) Pendekatan Praktikal (*Hands-on*)

Sebilangan besar peserta menyatakan bahawa pendekatan amali semasa kursus sangat membantu dalam pemahaman mereka terhadap sistem Linux. Mereka menghargai peluang untuk mencuba sendiri setiap langkah yang diajar dan merasakan kaedah ini lebih berkesan berbanding sesi teori semata-mata. Sebagai contoh seorang peserta menyatakan: "pelajaran secara *hands-ons* dan bukan teori, boleh terus cuba di terminal, *time practical*" yang menunjukkan bahawa bimbingan secara langsung di makmal sangat dihargai dan meningkatkan penglibatan peserta.

(ii) Pengajaran yang Jelas dan Mesra

Peserta turut memberikan maklum balas positif terhadap gaya penyampaian fasilitator sebagai contoh "suka *lecturer guide* untuk orang yang tak faham". Beberapa maklum balas menyebut bahawa tenaga pengajar bersifat mesra dan penyampaian yang diberikan adalah mudah difahami. Keadaan ini mewujudkan suasana pembelajaran yang selesa dan membolehkan peserta bertanya soalan serta mendapatkan bantuan apabila menghadapi kesukaran.

(iii) Pendedahan kepada Ilmu Baharu

Ramai peserta menyatakan keterujaan mereka kerana pertama kali didedahkan kepada sistem pengoperasian Linux. Kursus ini dilihat sebagai satu peluang untuk menambah ilmu pengetahuan dan memperluas kefahaman mereka terhadap alternatif selain sistem Windows. Antara kenyataan peserta yang menggambarkan perkara ini ialah "saya tak pernah tahu sebelum ini" dan "menambah ilmu pengetahuan tentang Linux yang saya tidak pernah pakai". Malah terdapat peserta yang menunjukkan minat mendalam terhadap penggunaan Linux selepas mengikuti kursus ini.

(iv) Penggunaan Perisian Sebenar

Penggunaan perisian sebenar seperti VirtualBox atau VMware semasa latihan amali turut menjadi salah satu elemen yang menarik perhatian peserta. Mereka menyatakan keseronokan dapat mencuba sendiri proses pemasangan Linux dalam persekitaran maya. Seorang peserta menyebut bahawa penggunaan "VMware untuk aktifkan Linux" merupakan pengalaman paling berkesan sepanjang kursus.

Terdapat satu lagi dapatan kualitatif daripada soalan terbuka "apakah cadangan anda untuk penambahbaikan pada masa akan datang?". Walaupun majoriti peserta menyatakan kepuasan terhadap pelaksanaan kursus dengan menjawab "Tiada" pada ruangan cadangan penambahbaikan, beberapa saranan membina telah dikenal pasti melalui analisis respons kualitatif. Cadangan-cadangan ini boleh dijadikan panduan dalam merancang penambahbaikan kursus pada masa hadapan.

Terdapat peserta yang mencadangkan agar bilangan tenaga pengajar ditambah atau peserta dibahagikan kepada kumpulan yang lebih kecil. Tujuan saranan ini adalah bagi memastikan setiap peserta mendapat perhatian yang mencukupi khususnya semasa sesi amali. Hal ini menunjukkan keperluan kepada sokongan individu yang lebih intensif dalam pembelajaran berasaskan kemahiran praktikal.

Beberapa peserta pula mencadangkan agar masa untuk latihan praktikal dipanjangkan dan kandungan teori dikurangkan. Cadangan ini mencerminkan kecenderungan peserta untuk mempelajari kemahiran secara langsung melalui pendekatan "learning by doing" yang dilihat lebih berkesan dalam konteks kursus berbentuk teknikal seperti ini.

Cadangan ketiga adalah berkaitan aspek teknikal seperti sambungan internet. Terdapat dua orang peserta menyarankan agar kursus dilaksanakan di makmal yang mempunyai capaian internet yang lebih stabil. Ini kerana beberapa aktiviti kursus terutamanya pemasangan perisian dan kemas kini sistem operasi memerlukan muat turun dalam talian. Capaian yang perlahan boleh mengganggu kelancaran aktiviti latihan amali.

Secara keseluruhannya cadangan-cadangan ini bersifat positif dan membina. Ia dapat membantu penganjur dalam merancang kursus akan datang dengan lebih baik namun tidak menjejaskan hakikat bahawa pelaksanaan kursus sedia ada telah mencapai tahap kepuasan yang tinggi dalam kalangan peserta.

5.0 PERBINCANGAN DAN CADANGAN KAJIAN LANJUTAN

Bahagian ini membincangkan berkenaan perbincangan, cadangan kajian lanjutan dan cadangan penambahbaikan.

5.1 PERBINCANGAN

Secara keseluruhan dapatan kajian ini mengesahkan bahawa kursus PSH 'Linux Ubuntu Untuk Semua' yang dilaksanakan di POLIMAS telah mencapai objektif utamanya. Jika dilihat dari segi keberkesanan pembelajaran, kursus ini berjaya meningkatkan pengetahuan dan kemahiran asas Linux dalam kalangan peserta yang majoritinya adalah pemula. Peningkatan skor purata pengetahuan sebelum dan selepas kursus sebanyak +0.95 adalah signifikan bagi sebuah kursus pendek dalam jangkamasa sehari. Dapatan ini selari dengan prinsip pembelajaran dewasa yang menekankan pembelajaran berasaskan pengalaman langsung (*experiential learning*) di mana peserta lebih mudah menguasai kemahiran melalui pendekatan praktikal (Knowles et al., 2020).

Objektif kedua kajian adalah dari segi kualiti pelaksanaan. Tahap kepuasan tinggi yang dilaporkan oleh peserta menunjukkan bahawa kursus ini telah diurus dan disampaikan dengan berkesan. Faktor-faktor seperti tenaga pengajar yang berdedikasi, silibus yang relevan, bahan kursus yang membantu dan suasana pembelajaran yang kondusif telah menyumbang kepada pengalaman pembelajaran yang positif. Kepuasan peserta ini penting kerana ia berkait rapat dengan motivasi untuk terus belajar dan mengekalkan penglibatan dalam pembelajaran sepanjang hayat (Tinto, 2025).

Dapatan kajian ini juga mempunyai implikasi yang lebih luas dalam konteks pendidikan politeknik dan kolej komuniti. Ia menyokong usaha institusi pendidikan tinggi dalam menawarkan program PSH terutamanya dalam bidang literasi digital. Sedia maklum bahawa kemahiran teknologi maklumat asas seperti penggunaan sistem operasi alternatif, pemahaman perisian sumber terbuka, dan kemahiran menyelesaikan masalah komputer menjadi semakin penting dalam era Revolusi Industri 4.0. Kursus seperti 'Linux Ubuntu Untuk Semua' boleh membantu melahirkan modal insan yang lebih celik teknologi dan serba boleh seterusnya meningkatkan kebolehpasaran graduan (*employability*).

Walaupun kursus ini menunjukkan keberkesanan yang memberangsangkan, terdapat beberapa limitasi kajian yang perlu diambil kira. Pertama adalah penilaian pengetahuan adalah berdasarkan persepsi kendiri peserta dan bukan melalui ujian objektif. Ini mungkin menyebabkan bias tertentu seperti penilaian retrospektif yang tidak tepat. Namun pendekatan retrospektif ini telah digunakan dengan berhati-hati untuk meminimumkan bias tersebut dan hasilnya disokong oleh maklum balas kualitatif peserta. Limitasi kedua adalah kajian ini hanya menilai impak serta-merta selepas kursus tanpa mengambil kira pengekalan pengetahuan

dalam jangka panjang. Oleh itu kajian susulan selepas tempoh tertentu (contohnya 3 atau 6 bulan) disarankan untuk menilai sejauh mana peserta masih menggunakan Linux atau mengingati kemahiran yang dipelajari.

5.2 CADANGAN KAJIAN LANJUTAN

Cadangan bagi kajian akan datang:

i. Mengkaji keberkesanan kursus serupa terhadap kumpulan umur berbeza atau golongan bekerja.
ii. Menjalankan satu kajian komparatif antara kursus bersemuka seperti ini dengan versi kursus dalam talian untuk melihat jika terdapat perbezaan keberkesanan dan kepuasan.
iii. Memasukkan penilaian kemahiran sebenar melalui tugasan praktikal dalam Linux sebelum dan selepas kursus.
iv. Merancang kursus lanjutan seperti "Linux Intermediate" atau kursus berkaitan pengaturcaraan (contohnya Python, C++ di Linux) sebagai sebahagian program PSH susulan daripada minat yang ditunjukkan peserta.

5.3 CADANGAN PENAMBAHBAIKAN

Terdapat beberapa cadangan penambahbaikan yang boleh dilaksanakan berdasarkan maklum balas peserta. Kursus akan datang berpotensi mencapai kesan pembelajaran yang lebih tinggi lagi sekiranya melaksanakan penambahbaikan seperti berikut:

i. Meningkatkan kemudahan infrastruktur dengan memastikan capaian internet yang stabil kerana ia mempengaruhi pengalaman latihan terutamanya dalam aktiviti yang memerlukan muat turun dalam talian.
ii. Mengekalkan nisbah fasilitator dan peserta yang kecil bagi menjamin setiap peserta mendapat bimbingan yang mencukupi semasa sesi amali.
iii. Menambah masa latihan praktikal berdasarkan maklum balas daripada peserta yang sangat menghargai aktiviti praktikal dalam pembelajaran mereka.

6.0 KESIMPULAN

Secara keseluruhannya dapatan kajian ini menunjukkan bahawa kursus Pembelajaran Sepanjang Hayat ‘Linux Ubuntu untuk Semua’ yang telah dilaksanakan di POLIMAS adalah berkesan dan berjaya mencapai objektif utamanya. Kursus ini telah memberi kesan positif kepada peserta dari segi peningkatan pengetahuan dan kemahiran asas berkaitan penggunaan sistem operasi Linux. Hal ini dibuktikan melalui peningkatan skor min bagi semua item penilaian pengetahuan selepas kursus berbanding sebelum kursus. Peserta yang sebelum ini kurang pendedahan terhadap Linux dilihat telah memperoleh asas kefahaman serta keyakinan awal untuk menggunakan sistem tersebut dalam situasi sebenar.

Selain itu tahap kepuasan peserta terhadap kursus ini juga sangat memberangsangkan. Skor min yang tinggi bagi setiap item penilaian kepuasan menunjukkan bahawa pendekatan penyampaian yang digunakan adalah berkesan khususnya gabungan aktiviti *hands-on*, penggunaan bahan bantu yang bersesuaian dan bimbingan fasilitator yang kompeten. Elemen-

elemen ini telah menyumbang kepada pengalaman pembelajaran yang lebih bermakna bagi para peserta.

Dari sudut yang lebih luas, keberkesanan kursus ini turut memberi sokongan kepada aspirasi negara dalam memperkasa agenda Pembelajaran Sepanjang Hayat (PSH) khususnya dalam bidang teknologi maklumat. Politeknik serta institusi latihan lain disarankan untuk meneruskan penganjuran kursus-kursus pendek yang bersifat praktikal dan menepati keperluan semasa. Program seperti ini telah terbukti dapat membangunkan kemahiran asas ICT dalam kalangan peserta dalam tempoh yang singkat dan berkesan walaupun dilaksanakan dalam skala yang kecil.

Akhir sekali kajian ini juga telah mengenal pasti beberapa cadangan penambahbaikan yang boleh dipertimbangkan oleh pihak penganjur terutamanya dalam aspek pelaksanaan kursus akan datang. Secara keseluruhannya objektif kajian ini telah tercapai dan diharap dapatan yang diperoleh dapat dijadikan rujukan kepada penyelidik dan pengendali PSH lain dalam merancang, melaksana serta menilai keberkesanan kursus jangka pendek dalam bidang teknologi. Inisiatif seperti 'Linux Ubuntu untuk Semua' merupakan satu langkah proaktif ke arah melahirkan masyarakat celik digital dan bersedia menghadapi cabaran dunia teknologi masa kini.

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THE POTENTIAL OF VIDEO RECORDINGS INCORPORATED WITH TEACHING MODULES TOWARDS STUDENT LEARNING PERFORMANCE

Suzan Binti Impak[1*], Tan Siew Ning[2]

[1,2]Civil Engineering Department, No 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu Sabah.

Suzan@polikk.edu.my, siewning@polikk.edu.my

Abstract

This study investigated the potential of incorporating video recordings into teaching modules to enhance student learning performance among students from DKA 4A and DKA 4B enrolled in the Water Quality Laboratory course during the 2024–2025 academic session 1. The objectives of the research were to evaluate the impact of video-incorporated laboratory modules on students' understanding of laboratory procedures, assess their accessibility and usability, and determine their effectiveness compared to traditional lab manuals. Data were collected using a Google Form questionnaire divided into three sections, each using a five-point Likert scale ranging from "strongly disagree" to "strongly agree." Findings from Section A, which focused on understanding laboratory procedures, showed a generally positive perception toward video-incorporated modules. A total of 77.8% of students either agreed or strongly agreed that the videos helped them understand the lab procedures more clearly. Similarly, 87% of students agreed that the videos improved their preparation before attending lab sessions, while 85.2% found that the video explanations aligned well with the experimental steps in the written manual. Moreover, 77.7% of respondents reported increased confidence in performing lab tests after watching the videos. These results indicate that the videos effectively enhanced students' understanding, preparedness, and confidence in conducting laboratory work. Section B focused on accessibility and usability of the video modules. The results revealed that students generally found the videos easy to access and use. A majority of 85.2% reported no issues playing the videos on their devices, while another 85.2% agreed that the videos were easily accessible both inside and outside the classroom. These findings suggest that the video materials were user-friendly and supported flexible, independent learning beyond class time. Section C examined the perceived learning impact of the video-incorporated modules compared to traditional lab manuals. The results showed that 61.1% of students agreed or strongly agreed that they learned more effectively using the video-based modules than with regular lab books. Furthermore, 85.2% of respondents recommended that future lab manuals include demonstration videos to enhance learning. Overall, the findings across all three sections indicate a strongly positive response toward the integration of video recordings in teaching modules. Students reported improvements in clarity, understanding, preparation, confidence, and accessibility. These results demonstrate that video-incorporated modules are a valuable and effective instructional tool that significantly enhances student learning performance and engagement in laboratory-based courses compared to traditional lab manuals.

Keywords: *interactive video; laboratory modules; video-incorporated modules*

1. Introduction

In civil engineering education, laboratory work is a critical component that allows students to apply theoretical knowledge in practical settings. However, one common challenge in laboratory sessions is the limited time lecturers must explain procedures in detail. Due to time constraints and large class sizes, instructions are often delivered rapidly, which may result in students missing key steps or not fully understanding the objectives of the experiment.

To address this challenge, integrating video recordings into laboratory modules offers a potential solution. Video demonstrations of lab procedures can provide students with clear,

step-by-step instructions that they can review at their own pace before, during, or after the lab session. This not only reduces the reliance on repeated explanations by the lecturer but also ensures consistency in the delivery of instructions.

The use of video-enhanced modules is supported by the principles of multimedia learning, where combining visual and verbal information improves comprehension and retention (Mayer, 2009). Previous studies have shown that instructional videos enhance student preparedness, confidence, and performance in laboratory tasks (Fiorella & Mayer, 2018; Ibrahim, Leng, & Samy, 2021).

Despite these advantages, limited research has examined the integration of video recordings specifically within laboratory modules in Malaysian polytechnics. This study therefore seeks to explore the potential of video-incorporated laboratory modules in improving student learning performance in civil engineering courses at Politeknik Kota Kinabalu.

1.1 Problem Statement

Laboratory sessions are an essential component of civil engineering education, as they provide opportunities for students to translate theoretical knowledge into practical skills. However, a recurring challenge in many laboratory classes is the limited time lecturers must deliver detailed explanations of experimental procedures. Due to time constraints and large class sizes, instructions are often delivered rapidly, leaving some students confused or unprepared to carry out the tasks effectively. This situation may result in incomplete understanding, procedural errors, or reduced learning outcomes.

Traditional approaches, such as printed laboratory manuals or brief verbal instructions, are often insufficient to address diverse student learning needs. While some students may grasp the procedures quickly, others require repeated exposure to instructions, which is not always feasible within the restricted time of a laboratory session.

The integration of video recordings into laboratory modules presents a potential solution to this problem. Videos allow students to review step-by-step procedures at their own pace, ensuring consistency in instruction and reducing the need for repeated lecturer explanations. Research in multimedia learning suggests that video-supported instruction enhances comprehension, motivation, and student performance. However, limited empirical evidence exists on the effectiveness of video-incorporated laboratory modules in the context of Malaysian polytechnics, particularly within civil engineering programs. Therefore, there is a need to investigate whether incorporating video recordings into laboratory teaching modules can improve student learning performance and better support the achievement of course learning outcomes.

1.2 Objective

The objective of this study is:

i. To evaluate the impact of video recordings incorporated within laboratory modules on students' understanding in performing lab procedures.

ii. To assess the accessibility of video-incorporated laboratory modules in supporting student learning.

iii. To determine the effectiveness of video-incorporated modules compared to

traditional lab manuals in enhancing student learning performance.

1.3 Scope of Study

The study involved DKA 4A and DKA 4B students from the Water Quality Laboratory course in Session 1 2024–2025. A Google Form questionnaire was administered, consisting of three sections; A understanding of lab procedures using video-incorporated modules, section B accessibility and usability of the modules, and section C, students' learning impact in term of the effectiveness of video-incorporated modules compared to traditional lab manuals in enhancing student learning performance.

2. Literature Review

In recent years, incorporating video recordings into teaching modules has emerged as a widely adopted instructional strategy in higher education and professional training. The advancement of digital technologies, along with the growing shift toward online and blended learning environments, has enabled educators to utilize video-based materials as tools for pre-class preparation, lecture enrichment, and interactive learning activities. When effectively designed and pedagogically aligned, such videos have the potential to enhance learners' comprehension, engagement, and knowledge retention. Nevertheless, the overall educational impact of video-based instruction is largely influenced by factors such as the quality of video design, the degree of interactivity, and how well the videos are integrated within the broader instructional framework.

A growing body of meta-analytic research highlights the educational benefits of video-enhanced teaching modules. In a comprehensive systematic review encompassing 105 randomized and quasi-experimental studies in higher education, Noetel et al. (2021) found that instructional videos tend to produce higher student learning performance compared to traditional text-based or lecture-only instruction. The study further revealed that the extent of improvement varies depending on the learning context and the quality of instructional design, with the most significant gains observed when videos are concise, well-organized, and effectively integrated into active learning activities.

Expanding on these findings, domain-specific studies have provided additional evidence supporting the effectiveness of video-based learning in applied and professional fields. In a meta-analysis focused on health education, Morgado et al. (2024) found that incorporating videos into instruction significantly enhanced both knowledge acquisition and procedural skill development compared to traditional lecture methods. Comparable results were reported in STEM disciplines, where Kuhlmann et al. (2024) observed that videos aided students in grasping complex visual and conceptual processes. Collectively, these findings emphasize that video recordings are particularly valuable when used to illustrate, demonstrate, or simulate processes that are difficult to convey through text alone.

However, systematic reviews consistently highlight that the use of videos alone does not necessarily lead to better learning outcomes unless they are thoughtfully integrated into the overall pedagogy. For instance, Deng and Gao (2024) found that incorporating embedded questions within instructional videos can increase student engagement and perceived learning, but significant improvements in performance occur only when these videos are complemented by in-class discussions or constructive feedback.

Across numerous studies, video length and segmentation have been identified as critical factors influencing instructional effectiveness. Mayer (2021) and subsequent experimental

replications found that shorter, well-segmented videos help maintain learner attention and minimize cognitive overload. Similarly, Noetel et al. (2021) reported that both student satisfaction and learning performance tend to decrease when videos exceed 10–15 minutes in length. These findings indicate that brevity in video design is not just a matter of presentation style but a cognitive necessity that enhances information processing and retention.

The integration of videos into teaching is most impactful when they are purposefully aligned with accompanying activities and assessments. Research on flipped classrooms demonstrates this synergy, where students first engage with conceptual videos independently and later apply their understanding through in-class discussions or problem-solving exercises. Deng and Gao (2024) found that learners who watched videos with embedded questions achieved the highest performance when subsequent classroom activities reinforced the video content. This highlights the critical role of instructional alignment effective learning outcomes depend not only on video design but also on how well the videos are integrated within a cohesive teaching module.

Recent developments in learning analytics have deepened understanding of how students interact with video-based learning materials. Kuhlmann et al. (2024), through an analysis of clickstream data, discovered that active engagement behaviors such as pausing, re-watching segments, taking notes, and responding to in-video questions were significant predictors of improved learning outcomes in STEM courses. These findings suggest that the quality of engagement matters more than the quantity of viewing; it is cognitive engagement, rather than passive watching, that drives meaningful learning gains from video-based instruction.

The effectiveness of video-enhanced instruction differs across academic disciplines. In health and medical education, for instance, videos are frequently used to demonstrate procedural skills, enabling students to observe expert techniques prior to hands-on practice. Morgado et al. (2024) reported notable gains in both theoretical comprehension and clinical performance among learners who engaged with video-based instructional modules.

In STEM disciplines, videos play a crucial role in helping students visualize abstract concepts and work through complex problem-solving processes. Kuhlmann et al. (2024) found that engineering students achieved better learning outcomes when instructional videos demonstrating step-by-step procedures were combined with problem-based learning activities. In contrast, research in language and humanities education presents more mixed results—while videos can effectively improve listening and comprehension, their impact on productive skills tends to be limited unless integrated with interactive or communicative practice (Wong et al., 2024). Overall, these disciplinary variations highlight that the effectiveness of video-based learning depends on how well the medium's visual and demonstrative strengths align with the cognitive requirements of the subject matter.

Despite the promising evidence, several methodological limitations constrain the generalizability of existing findings. Many studies rely on short-term assessments that capture immediate learning gains but fail to measure long-term retention or the transfer of knowledge to new contexts. Additionally, the inconsistent reporting of key video design elements such as duration, narration style, and interactivity makes it difficult to compare results across studies (Noetel et al., 2021). Few investigations adequately control for novelty effects or self-selection bias, as students who engage more deeply with videos may already possess higher motivation and stronger self-regulated learning skills. Furthermore, issues of equity and accessibility remain insufficiently examined. As Morgado et al. (2024)

emphasized, factors such as technological access, internet bandwidth, and the availability of high-quality captions can significantly influence which learners benefit most from video-based instruction.

In summary, while the integration of video recordings within teaching modules holds substantial potential to enhance student learning performance, its effectiveness is contingent upon thoughtful design, meaningful interactivity, and pedagogical coherence. When grounded in multimedia learning principles, optimized for cognitive efficiency, and embedded within active learning frameworks, videos can promote deeper understanding, sustained engagement, and knowledge transfer. As higher education continues to expand into hybrid and digital learning environments, refining and integrating video-based teaching strategies remains a critical focus for students and educators.

3. Methodology

3.1 Research Design

This study employed a quantitative survey design to examine the potential of video recordings integrated within laboratory teaching modules in enhancing student learning performance. A structured questionnaire was developed to collect data on students' understanding, accessibility, and preferences regarding video-incorporated modules.

3.2 Population and Sample

The population for this study consisted of Semester 4 students enrolled in the Water Quality Laboratory course (DKA 4A and DKA 4B) at Politeknik Kota Kinabalu, during the 2024–2025 academic session 1. Using total population sampling, all 54 students from the two classes were selected as respondents to ensure comprehensive representation.

3.3 Research Instrument

Data were collected using a Google Form questionnaire consisting of three sections. Sections A understanding of lab procedures using video-incorporated modules, section B accessibility and usability of the modules, and section C students' learning impact in term of the effectiveness of video-incorporated modules compared to traditional lab manuals in enhancing student learning performance. Each section included several items measured on a five-point Likert scale, ranging from strong disagreement to strong agreement. The items were designed to align with the research objectives and to capture students' perceptions in a structured manner.

3.4 Data Collection Procedure

The questionnaire link was distributed to all respondents, who were given 30 minutes to complete the survey. Participation was voluntary, and students were assured that their responses would remain confidential and be used solely for research purposes.

3.5 Reliability and Validity

To ensure the reliability of the instrument, a pilot test was conducted with a small group of students who were not part of the actual sample. The internal consistency of the questionnaire was measured using Cronbach's alpha, with all sections achieving values above the acceptable threshold of 0.70, indicating good reliability. Content validity was established through expert review by lecturers from the Civil Engineering Department, who examined the questionnaire items for clarity, relevance, and alignment with the research objectives.

3.6 Data Analysis

The data collected was extracted into Microsoft Excel and analyzed using descriptive statistics to summarize students' responses. The findings were presented in the form of pie charts and bar charts, allowing for clear visualization of patterns and trends in the data.

A survey comprising three sections has been disseminated among fifty-four students who attend water quality laboratory class. Sections A understanding of lab procedures using video-incorporated modules, section B accessibility and usability of the modules, and section C students' learning impact in term of the effectiveness of video-incorporated modules compared to traditional lab manuals in enhancing student learning performance.

Each section has few substitutes question to understand more on the potential of interactive video in laboratory learning experiences. Each respondent has 30 minutes of time to fill in the survey question which is sent via link to all respected respondents. All data has been analysis to integrate the findings. Finding presented in pie and bar chart to understand the respond of respected respondent.

4. Finding and Analysis

Finding and analysis consist of section A, B, and C.

4.1 Section A

The analysis of students' responses in Section A highlights a generally positive perception toward the use of video-incorporated modules in supporting laboratory learning. Across all four items, most students indicated either agree or strongly agree, with only a small proportion of neutral responses observed.

Figure 4.1 shows the bar chart visualization for Section A results. It clearly shows that most students fall into the "Agree" and "Strongly Agree" categories across all items, with very minimal neutral responses.

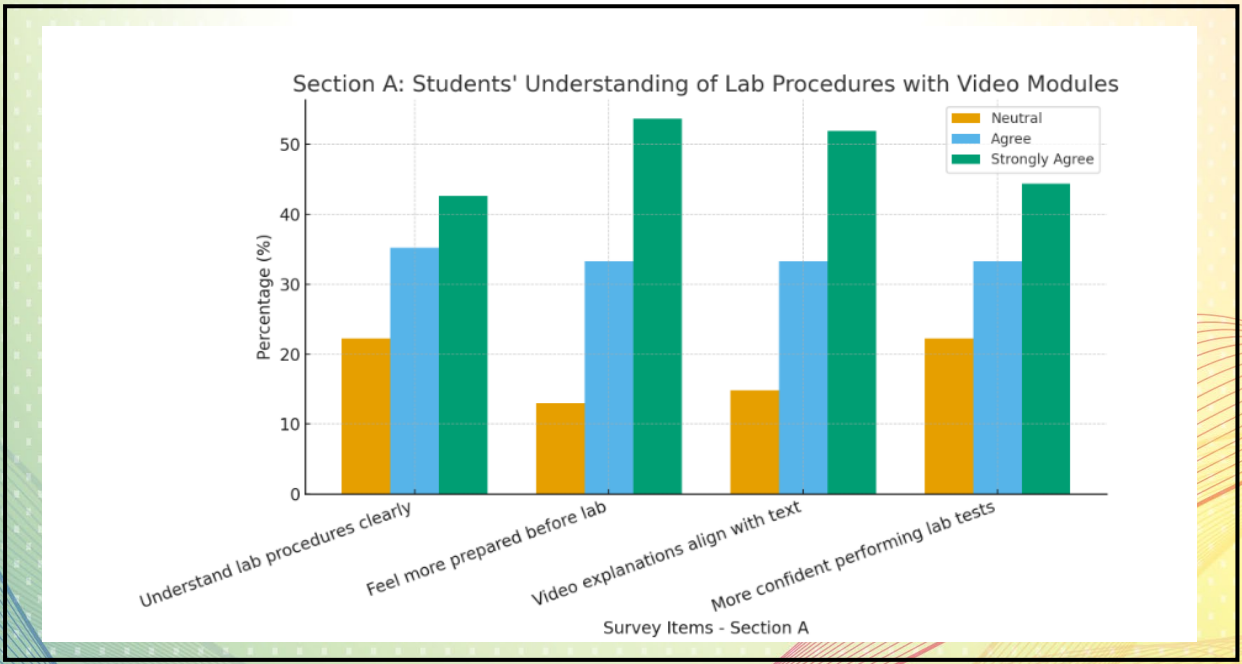


Figure 4.1: Survey Item for Section A

Figure 4.2 to figure 4.5 shows pie charts for each question in Section A. Each chart clearly shows that most students either agree or strongly agree that the video-incorporated modules improved their lab learning, while the neutral responses remain relatively small.

i. Clarity of Lab Procedures

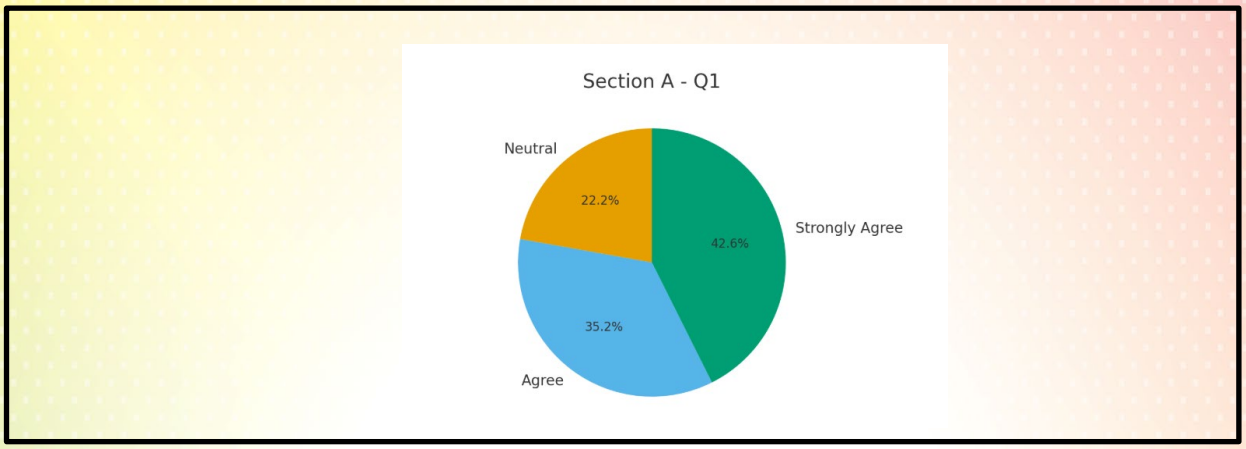


Figure 4.2: Survey Item for Clarity of Lab Procedures

A total of 77.8% of students either agreed (35.2%) or strongly agreed (42.6%) that the videos helped them understand the laboratory procedures more clearly. Only 22.2% remained neutral, and no students disagreed, indicating that the majority found the videos effective in enhancing clarity.

ii. Preparation Before Entering the Lab

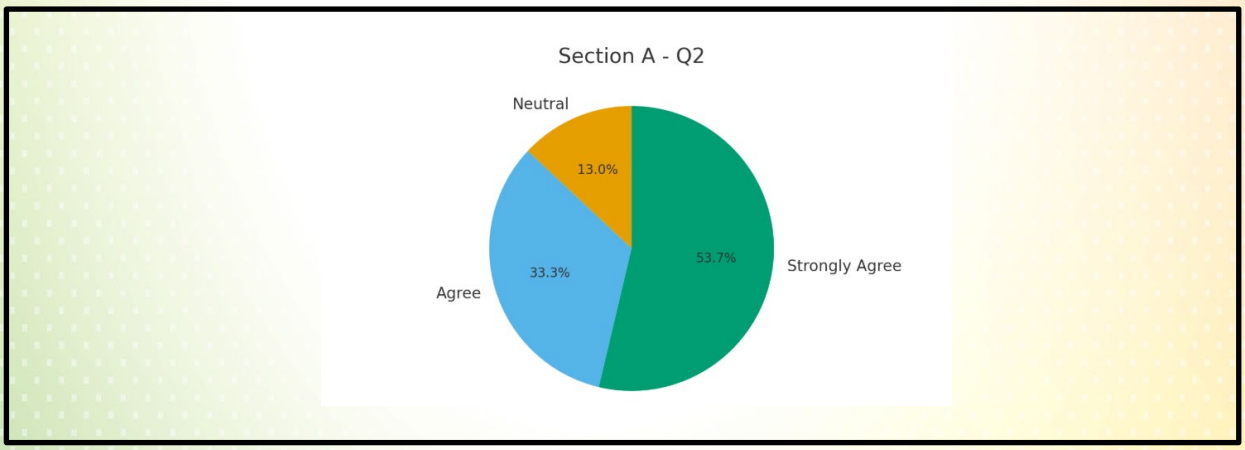


Figure 4.3: Survey Item for Preparation Before Entering the Lab

More than half of the respondents (53.7% strongly agreed, 33.3% agreed) felt that the videos helped them feel more prepared before attending lab sessions. Only 13% gave a neutral response, further supporting the potential of video materials as a pre-lab preparation tool.

iii. Alignment of Explanations with Experimental Steps

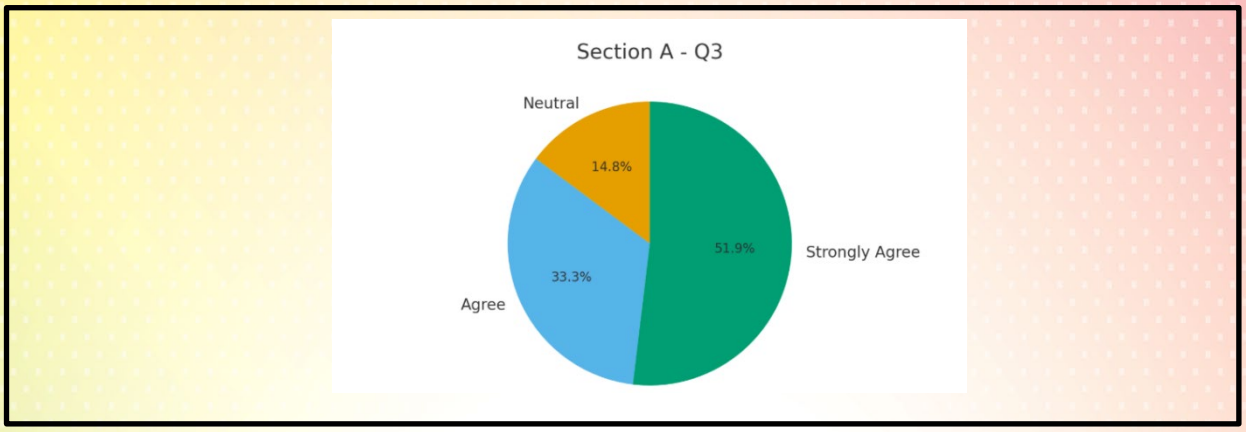


Figure 4.4: Survey Item for Alignment of Explanations with Experimental Steps

About 85.2% of students agreed (33.3%) or strongly agreed (51.9%) that the video explanations aligned well with the experimental steps provided in the text. 14.8% remained neutral, showing that the majority acknowledged consistency between the video and written instructions.

iv. Confidence in Performing Lab Tests

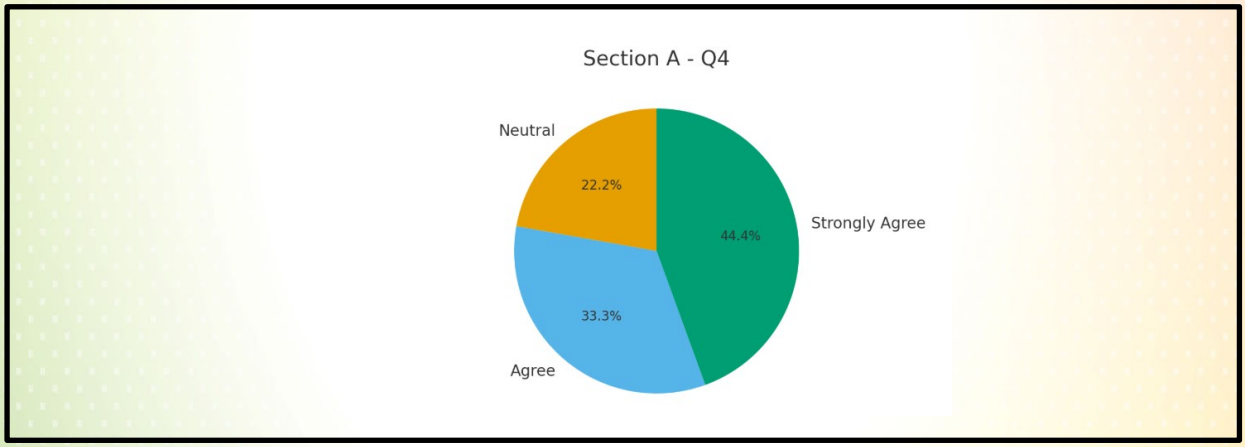


Figure 4.5: Survey Item for Confidence in Performing Lab Tests

A significant proportion (77.7%) of students agreed (33.3%) or strongly agreed (44.4%) that the videos increased their confidence in carrying out lab experiments. 22.2% were neutral, but none disagreed, reflecting overall confidence-building effects.

As a summary of Section A, overall, the findings indicate that video-incorporated modules positively influenced students' understanding, preparation, and confidence in performing lab procedures. The strong majority of "agree" and "strongly agree" responses (ranging between 77% and 87% across all items) demonstrate that video support is a valuable instructional aid in laboratory learning.

4.2 Section B

The analysis of students' responses in Section B highlights a generally positive perception of the accessibility of video-incorporated modules. Across all two items, most students indicated either agree or strongly agree, with only a small proportion of neutral responses observed.

Figure 4.6 clearly shows that most students either agree or strongly agree on both accessibility and smooth playback of the videos, with very few neutral responses.

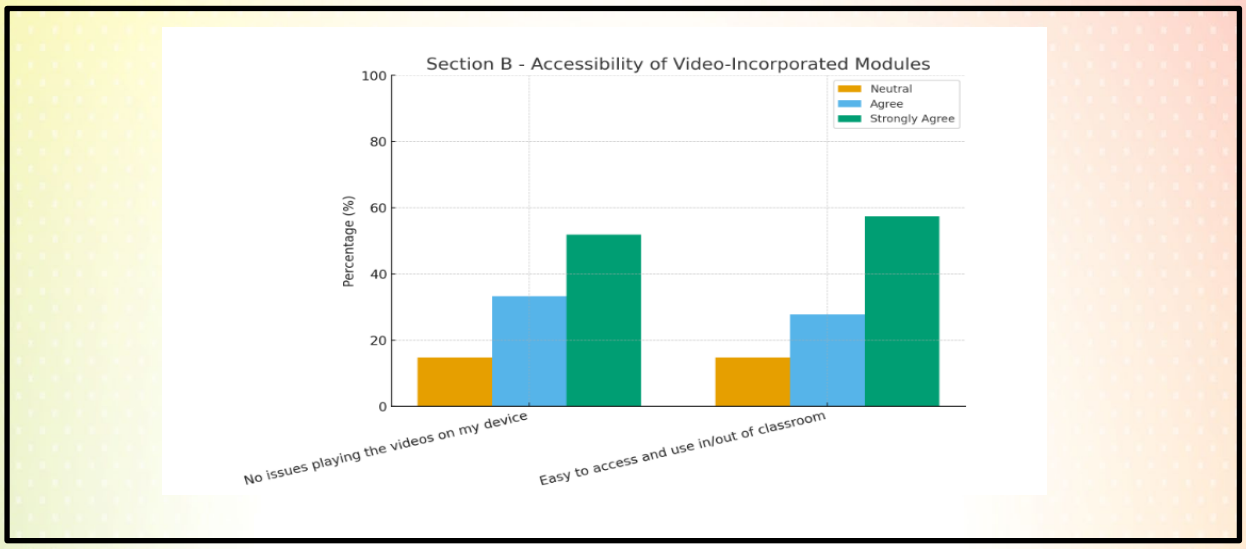


Figure 4.6: Survey Item for Accessibility of Video-Incorporated Modules

Figure 4.7 to figure 4.8 shows pie charts for each question in Section B. The pie charts show that most students strongly agreed with both statements, indicating that the videos are accessible, easy to use, and play smoothly on their devices.

i. Issues Playing Video on Device

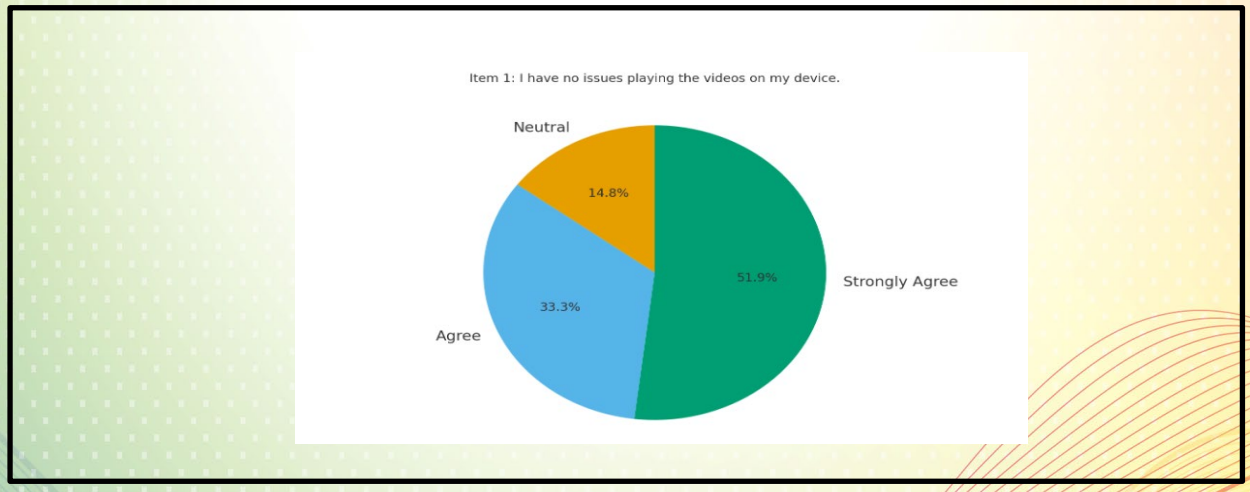


Figure 4.7: Issues Playing Video on Device

The results indicate that most respondents (51.9%) strongly agreed that they did not face any issues playing the videos on their devices. Meanwhile, 33.3% agreed, and only 14.8% remained neutral. These findings suggest that the video format used in the teaching

module was highly compatible across different devices, allowing students to access and view the content without technical difficulties.

The absence of disagreement highlights the reliability and functionality of the videos provided.

ii. Easy To Access Inside and Outside Classroom

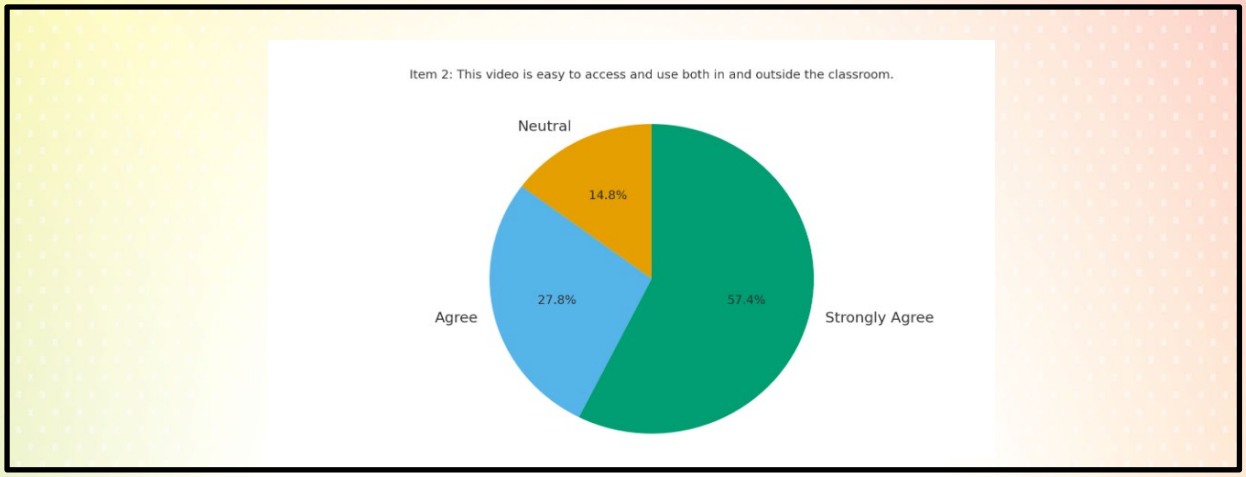


Figure 4.8: Easy To Access Inside and Outside Classroom

For this item, the findings demonstrate that more than half of the students (57.4%) strongly agreed that the videos were easy to access and use. Additionally, 27.8% agreed with the statement, while 14.8% responded neutrally. These results suggest that the videos were not only accessible but also user-friendly, supporting flexible learning both inside the classroom and during independent study.

Overall, the results of Section B collectively highlight students' positive perceptions of the videos incorporated within the teaching modules. A large proportion of students strongly agreed with both statements, indicating that the videos were accessible, easy to use, and free from playback issues. These findings align with existing literature that emphasizes the importance of accessible and reliable digital resources in improving students' engagement and learning performance. By ensuring technical compatibility and ease of use, the integration of videos into teaching modules can significantly enhance the learning experience in civil engineering education.

4.3 Section C

The analysis of students' responses in Section C highlights a generally positive perception of the students' learning impact in term of the effectiveness of video-incorporated modules compared to traditional lab manuals in enhancing student learning performance.

Figure 4.9 clearly shows that the findings clearly show that most students have a very positive perception of the video-incorporated modules.

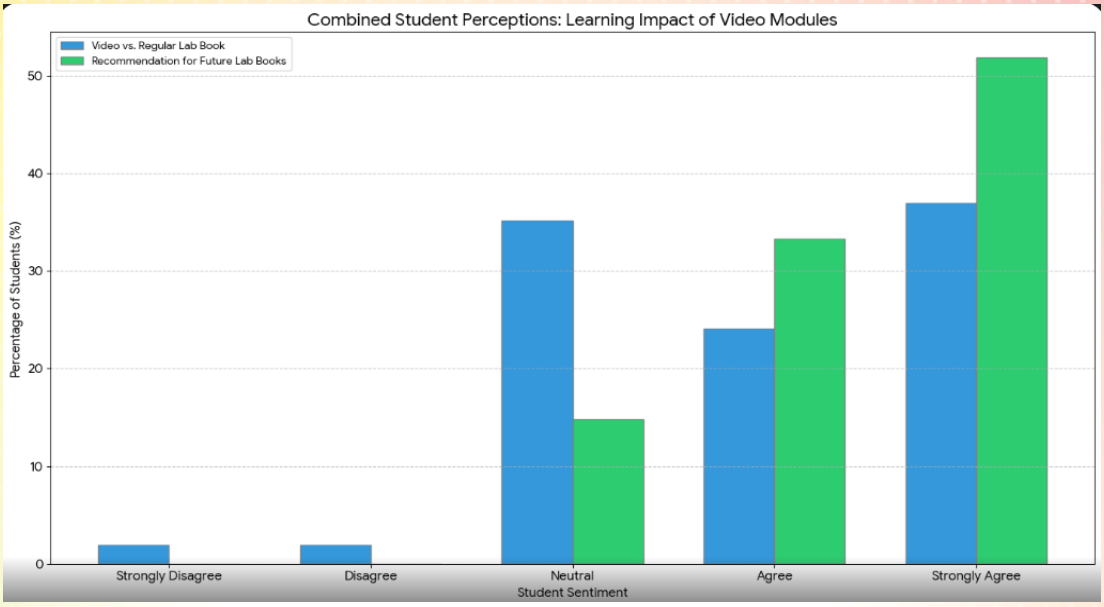


Figure 4.9 Students' learning impact

Figure 4.9 shows the combined results in the bar chart show that students hold a highly positive perception of video-incorporated learning modules compared to traditional lab books.

For the item "Video vs. Regular Lab Book," the majority of students expressed favorable responses about 61.1% agreed or strongly agreed that they learned more effectively using the video-based modules, while 35.2% remained neutral. Only a very small percentage (around 3.8%) disagreed or strongly disagreed. The bar chart illustrates students' perceptions of learning effectiveness when using the eBook (with video recordings) compared to a regular lab book. As summary, overall, 61.1% of students agreed that using the video-incorporated eBook enhanced their learning effectiveness compared to a traditional lab manual. The minimal disagreement and moderate neutral responses indicate that most students found the video-supported material beneficial for understanding and engagement, though a small group remained uncertain about its added value.

For the item "Recommendation for Future Lab Books," a large majority of respondents expressed strong support for incorporating demonstration videos into future lab books. Specifically, 51.9% strongly agreed and 33.3% agreed, indicating that over 85% of students endorsed the idea. Meanwhile, 14.8% of students remained neutral, and none disagreed. Overall, the findings suggest a highly positive perception of integrating demonstration videos, reflecting students' preference for more interactive and visually guided learning materials in laboratory courses.

5. Conclusion

These findings confirm that video recordings are a valuable and effective instructional tool that can significantly enhance students' understanding of laboratory procedures, surpassing the learning impact of traditional lab manuals. Students strongly prefer video-supported modules, consistently reporting higher engagement, clearer comprehension, and greater confidence when learning through visual demonstrations. Their collective feedback

signals a clear demand for continued integration of video-based materials in future teaching modules.

However, these benefits do not come without limitations. Unequal access to reliable devices, stable internet, and conducive digital learning environments may prevent some students from fully experiencing the advantages of video-enhanced instruction. At the same time, the development, recording, editing, and maintenance of high-quality instructional videos place substantial demands on lecturers, often adding to an already heavy workload. Without institutional support, shared resources, or dedicated production time, the sustainability of video-based teaching may be constrained. Likewise, producing high-quality videos demands significant lecturer time, technical skill, and ongoing maintenance in which adding weight to existing academic workloads. Without structural support, the momentum behind video-supported teaching may fade despite its promise.

For institutions such as polytechnics, these findings signal the need for forward-looking policies and curriculum design strategies. Administrators should consider formalizing video-based learning as part of standard teaching practice, supported by infrastructure such as campus-wide high-speed internet, device-loan schemes, and low-bandwidth or offline-access alternatives. Curriculum teams should embed video demonstrations into core modules, aligning them with learning outcomes, assessments, and practical sessions to ensure consistent pedagogical value. Policies that recognize video production as legitimate academic workload through workload credits, media support units, or shared content repositories, would help sustain lecturer motivation and ensure long-term quality.

Looking ahead, future studies should examine how technological barriers and workload pressures influence the effectiveness of video-based teaching across diverse student populations. Experimental designs, such as randomized or cluster-controlled trials, can offer stronger causal evidence for the impact of video modules on performance. Longitudinal studies can track whether these benefits endure across semesters or influence students' practical competencies over time. Additional research should also explore innovative, low-cost production models, collaborative video creation across departments, and strategies for accessible delivery in low-bandwidth environments to ensure equitable learning for all.

Ultimately, while video-enhanced teaching offers clear educational advantages, its success in polytechnic settings depends on policies and curriculum structures that support access, sustainability, and pedagogical alignment.

These findings prove that video recordings are a valuable and effective instructional tool that can significantly improve the learning experience in understanding lab procedures, and effective compared to traditional lab manuals. Overall Summary, the findings indicate a strong student preference for integrating video demonstrations within teaching modules. Students not only perceive videos as more effective for understanding and engagement but also advocate for their inclusion in future instructional materials, confirming the significant learning impact of video-supported modules.

In short, video-supported teaching modules hold strong potential, but their long-term effectiveness depends on addressing the technological and human constraints that stand alongside them.

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Analisis Literatur Sistematik menggunakan Model PRISMA terhadap penggunaan aplikasi *Canva* sebagai media interaktif dalam pengajaran dan pembelajaran abad ke-21

Nur Angriani Nurja[1*], Efrianti Robani[1], Raja Ahmad Raja Husin[1]
[1]Jabatan Pengajian Am, Politeknik Kota Kinabalu, Sabah, Malaysia
*angriani@polikk.edu.my

Abstrak

Canva merupakan salah satu aplikasi reka bentuk grafik digital yang sangat efisien masa kini. Antara muka intuitif, fitur-fitur menarik, templat sedia ada yang kreatif dan pelbagai kelebihan lagi menjadikan aplikasi *Canva* satu pilihan utama untuk mereka bentuk grafik. Justeru, kajian ini bertujuan untuk menganalisis keberkesanan penggunaan aplikasi *Canva* sebagai media interaktif dalam pengajaran dan pembelajaran (PdP) abad ke-21. Metodologi kajian ini berbentuk tinjauan literatur sistematik untuk menganalisis atikel-artikel ilmiah berkaitan keberkesanan penggunaan aplikasi *Canva* sebagai media pengajaran dan pembelajaran yang interaktif bagi abad ke-21. Sebanyak 30 artikel ilmiah dalam tempoh 5 tahun terkini iaitu antara tahun 2020 hingga 2024 diperoleh melalui pangkalan data *Scopus, MyJurnal* dan *Google Scholar*. Metod penelitian tinjauan literatur sistematik ini melibatkan proses pemilihan, mendapatkan, membaca dan menilai (evaluation) pelbagai artikel ilmiah yang mempunyai hubungan dengan persoalan kajian melalui model PRISMA. Data yang diterangkan adalah hasil kajian berkaitan keberkesanan penggunaan aplikasi *Canva* yang telah dijalankan oleh pengkaji terdahulu. Hasil tinjauan literatur sistematik menunjukkan bahawa aplikasi *Canva* meningkatkan kreativiti pelajar dalam mereka bentuk grafik dalam PdP. Aplikasi *Canva* menjadi medium PdP yang interaktif untuk mengekpresikan idea-idea kreatif dalam reka bentuk digital dalam pelaksanaan tugasan atau penilaian berterusan. Kesimpulannya, aplikasi *Canva* merupakan satu aplikasi digital yang sangat efektif sebagai media interaktif dalam PdP abad ke-21.

Kata kunci: *Aplikasi Canva, pengajaran dan pembelajaran, media interaktif, pembelajaran abad ke-21*

1. Pengenalan

Media pembelajaran merupakan komponen penting dalam mencapai dan menunjangi hasil pembelajaran. Di samping itu, media pembelajaran berperanan sebagai wahana utama yang digunakan pensyarah atau pendidik dalam proses pengajaran dan pembelajaran (PdP) untuk menyampaikan material PdP kepada pelajar. Pendidik memerlukan perantara atau media pembelajaran untuk menghidupkan suasana PdP yang interaktif bagi menarik perhatian pelajar (Zaini, 2017; Sutrisno, 2023). Justeru, pendidik mempunyai tanggungjawab untuk meningkatkan kompetensi dalam penyediaan dan penguasaan teknologi media pembelajaran agar PdP yang disampaikan keada pelajar berdaya guna dan berhasil.

Umum mengetahui bahawa teknologi muktahir menggalakkan pendekatan PdP menjadi lebih dinamik, kreatif dan inovatif dalam menjadi media interaktif yang berupaya untuk menarik perhatian pelajar terutama dalam proses PdP abad ke-21. Nur Fatin et al. (2021) menyatakan bahawa teknologi merupakan elemen penting di era globalisasi kerana kemampuan teknologi dalam mencakupi aspek kehidupan seperti tuntutan ilmu pengetahuan, komunikasi, capaian akses pelagai jenis maklumat dan sebagainya. Bertitik tolak daripada hal ini, pendidik menggunakan media pengarajaran sebagai alat penyampaian maklumat semasa menjalankan PdP untuk memberi kefahaman dan seterusnya mempengaruhi kongnitif, psikomoto serta afektif pelajar.

Penyediaan media pembelajaran yang menarik, kreatif dan informatif merupakan salah satu wadah bermakna untuk mencapai hasil pembelajaran yang optimum dalam proses PdP. Arus globalisasi memberi dampak dan perubahan kepada semua aspek kehidupan manusia;

khususnya aspek pendidikan. Wulandari dan Mudinillah (2022) menjelaskan bahawa dampak globalisasi mendorong para pendidik untuk mengadaptasi perubahan dalam teknologi maklumat dan komunikasi bagi menghasilkan media interaktif PdP. Secara tidak langsung, perkembangan teknologi maklumat dan komunikasi mempengaruhi perubahan teknologi pendidikan itu sendiri yang memberi manfaat dalam dunia pendidikan.

Pada era digital kini, terdapat pelbagai media pembelajaran yang boleh diperoleh secara dalam talian. Salah satu pilihan untuk penghasilan media pembelajaran yang boleh diakses dengan mudah ialah *Canva*. Berdasarkan informasi dari pada laman sesawang *canva.com*, *Canva* merupakan aplikasi interaktif atau alat reka bentuk grafik dalam talian yang boleh digunakan oleh semua lapisan masyarakat secara percuma atau berbayar. Aplikasi *Canva* ini sangat ringkas dan mudah digunakan, malah boleh diakses melalui peranti mudah alih, tablet atau komputer. *Canva* bukan sahaja digunakan oleh pendidik untuk mencita dan menghasilkan media PdP, ia juga boleh dimanfaatkan secara langsung oleh pelajar untuk mereka bentuk pelbagai produk pembelajaran seperti logo, poster, slaid pembentangan, iklan dan sebagainya. Berbanding dengan aplikasi reka bentuk atau editor yang lain, *Canva* lebih memfokuskan pada aspek reka bentuk, menyediakan contoh reka bentuk sedia ada untuk digunakan sebagai rujukan mahupun templat (Sari et al., 2024). Justeru, dapat dilihat di sini bahawa *Canva* mempunyai komponen grafik yang mudah difahami, mendorong pembelajaran visual dan melatih literasi visual pengguna, iaitu pendidik serta pelajar.

Kehadiran aplikasi *Canva* dalam dunia pendidikan menjadi satu wadah penting untuk penghasilan media pembelajaran PdP secara interaktif (Resmini et al., 2021; Sari et al., 2024). *Canva* merupakan platform dalam talian yang menyediakan pelbagai reka bentuk grafik dan templat seperti infografik, slaid pembentangan, resume, risalah, poster serta suntingan video. Malahan, *Canva* berupaya untuk membantu dan memudahkan pendidik untuk penghasilan media pembelajaran dan hal ini akan memudahkan pelaksanaan aktiviti PdP berasaskan teknologi, kemahiran serta kreativiti. Kemudahan yang terkandung dalam *Canva* bukan sahaja membantu dalam penyediaan media pembelajaran, aplikasi ini juga merupakan medium yang mampu menyokong kreativiti pelajar dalam melaksanakan tugasan yang diberi oleh pensyarah atau guru (Kharissidqi dan Firmansyah, 2022).

Selain itu, akaun pengguna *Canva for Education* memberi kelebihan kepada pendidik mahupun pelajar untuk menggunakan fitur-fitur *premium* seperti yang terkandung dalam *Canva Pro.* Pendidik dan pelajar boleh menyunting video, slaid pembentangan, mencipta imej kecerdasan buatan atau *artificial intelligence* (AI) dan ciri-ciri sokongan yang lain. Menurut Saza (2023; Purwadi & Lestari, 2024), penggunaan *Canva* sebagai media interaktif dalam PdP mampu meningkatkan minat dan menyuntik elemen kreativiti dan inovatif bagi aktiviti PdP. Di samping itu, *Canva* juga dilihat sebagai media pembelajaran yang menarik, mudah dan menjimatkan masa. Lantaran itu, kajian ini bertujuan untuk menganalisis keberkesanan penggunaan aplikasi *Canva* sebagai media interaktif dalam pengajaran dan pembelajaran (PdP) abad ke-21. Kajian tinjauan literatur sistematik ini dijalankan dengan berpandukan garis panduan model *Preferred Reporting Items for Systematic Review and Meta-Analyses* (PRISMA) untuk menjawab persoalan seperti berikut:

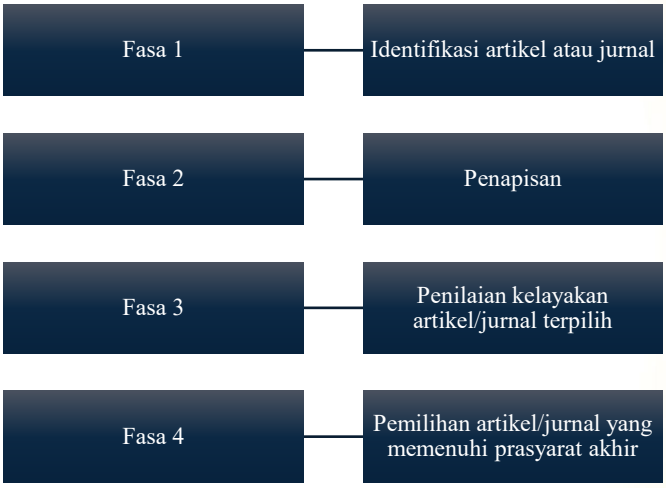
i. Apakah trend kajian/penyelidikan seperti tahun penerbitan, negara dan pendekatan kajian untuk penyelidikan penggunaan *Canva* sebagai media interaktif dalam PdP abad ke-21?

ii. Apakah impak atau keberkesanan penggunaan *Canva* sebagai media interaktif dalam PdP abad ke-21?

2. Metodologi

Kajian ini dilaksanakan berdasarkan model *Preferred Reporting Items for Systematic Review and Meta-Analyses* (PRISMA) untuk memastikan maklumat yang diperoleh sahih dan dipercayai. Berdasarkan garis panduan model PRISMA, pengkaji berupaya untuk memproses maklumat langkah demi langkah bagi memastikan tinjauan literatur yang dihasilkan berkualiti (Hayrol et al., 2019; Ng & Maat, 2022). Seterusnya, Sierra- Correa dan Kintz (2015; Ng & Maat, 2022) menghuraikan bahawa model PRISMA mempunyai kelebihan untuk mentakrif persoalan kajian yang jelas dalam penyelidikan sistematik, mengenal pasti kriteria kelayakan dan pengecualian serta berupaya meneliti pangkalan data literatur saintifik dalam masa ditetapkan.

Kajian tinjauan literatur sistematik merupakan salah satu disiplin penyelidikan yang dijalankan untuk mengenal pasti, memilih dan menilai secara kritis kajian-kajian terdahulu untuk menjawab persoalan yang dikemukakan dengan jelas (Shaffril et al., 2021; Nurul & Shahabuddin, 2023). Melalui kajian ini, pengkaji akan mengakses dan menganalisis data yang berkaitan dengan keberkesanan penggunaan aplikasi *Canva* sebagai media interaktif dalam PdP. Berpandukan carta alir model PRISMA, Rajah 1 menunjukkan empat (4) fasa yang dilaksanakan untuk mendapatkan artikel yang layak.



Rajah 1: Carta Alir Model PRISMA

2.1 Strategi Pencarian Sistematik

Identifikasi

Artikel untuk kajian tinjauan literatur sistematik ini telah dikenal pasti melalui tiga (3) pangkalan data iaitu *Scopus, MyJurnal* dan *Google Scholar*. Pengkaji telah menggunakan beberapa kata kunci yang merujuk dengan penggunaan *Canva* sebagai media interaktif PdP abad ke-21. Pencarian artikel dalam **Fasa 1: Identifikasi artikel atau jurnal** dilaksanakan dengan menggunakan kata kunci dalam bahasa Malaysia dan ahasa Inggeris. Jadual 1 menunjukkan senarai pencarian artikel berdasarkan kata kunci berkaitan dalam tiga pangkalan data yang digunakan.

Jadual 1: Kata kunci dan pangkalan data pencarian artikel.

Pangkalan Data	Kata Kunci
Scopus	TITLE-ABS-KEY(“canva” OR “canva application” OR “21st-century education” OR “teaching and learning”) AND (LIMIT-TO (PUBYEAR,2024) OR LIMIT-TO (PUBYEAR,2023) OR LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2020) AND (LIMIT-TO (SUBJECTAREAS)
MyJurnal	“canva” AND “canva application” AND “media interaktif” AND “interactive learning media canva application”
Google Scholar	“canva” AND “teaching and learning” AND “canva sebagai media interaktif” AND “pembelajaran abad ke-21” AND “penggunaan canva dalam pembelajaran abad ke 21” AND “interactive learning media canva application”

Penapisan

Selanjutnya, selepas pencarian artikel dalam **Fasa 1: Identifikasi artikel atau jurnal** dijalankan, pengkaji akan mengenal pasti artikel-artikel yang dipilih untuk proses dalam **Fasa 2: Penapisan**. Dalam fasa penapisan, artikel yang telah dipilih daripada tiga pangkalan data tersebut akan ditapis berdasarkan syarat pemilihan yang ditetapkan secara khusus. Artikel-artikel yang dimuat turun adalah berdasarkan syarat-syarat seperti mempunyai akses terbuka, artikel dalam bidang sains sosial dan artikel yang memberi fokus kepada penggunaan *Canva* sebagai media interaktif dalam PdP abad ke-21. Sebelum proses penapisan ini, sejumlah 3,815 artikel diperoleh daripada *Scopus*, 692 daripada *MyJurnal* dan 1,040 daripada *Google Scholar*. Selepas proses penapisan, artikel *Scopus* telah dikurangkan kepada 193 artikel, *MyJurnal* dikurangkan kepada 32 artikel dan *Google Scholar* dikurangkan kepada 208 artikel. Jadual 2 menunjukkan kriteria atau syarat pemilihan artikel untuk kajian ini.

Jadual 2: Kriteria/syarat pemilihan artikel.

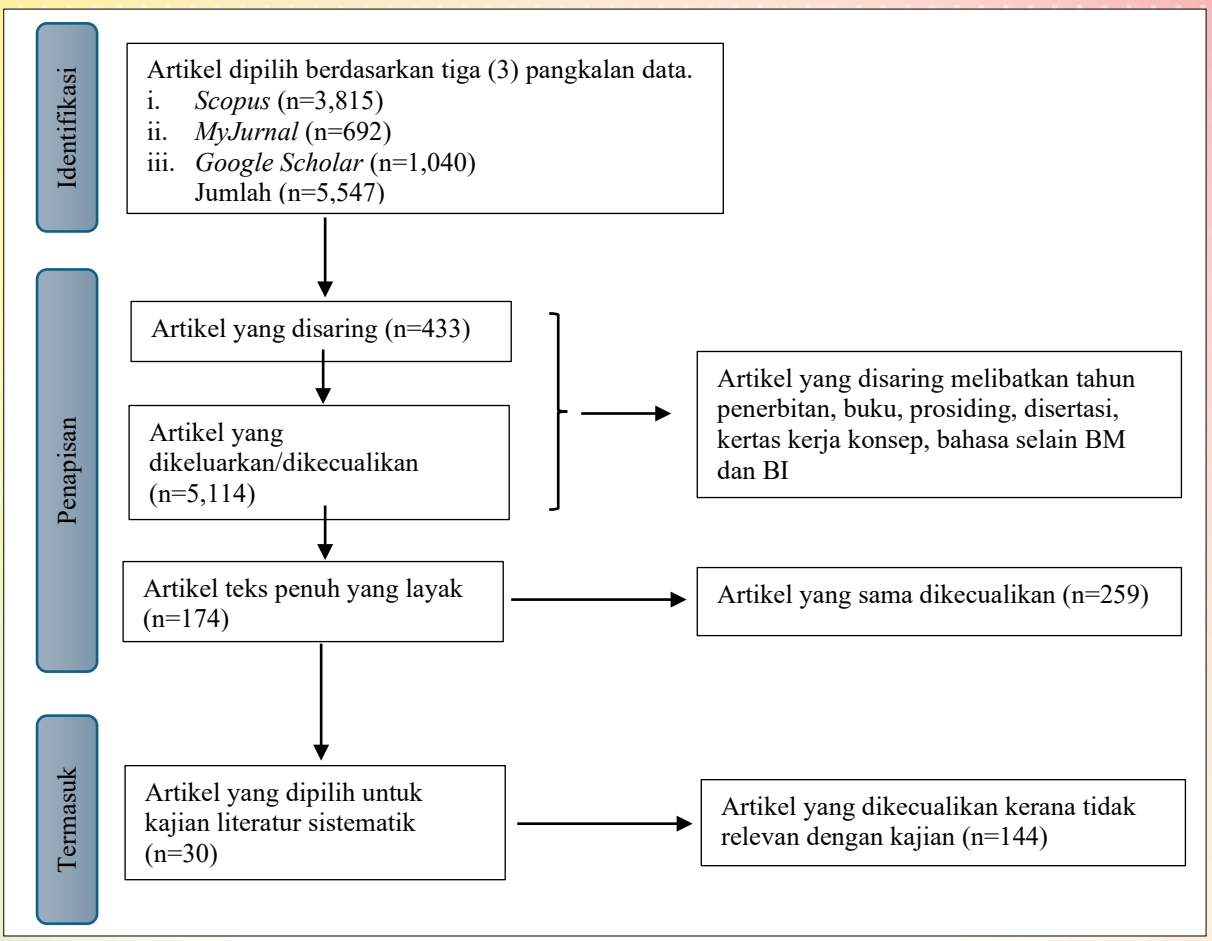
Kriteria/Syarat	Artikel diterima	Pengecualian/Ditolak
Jenis artikel	Artikel/jurnal penyelidikan	Kertas kerja konsep, bab dalam buku, kertas cadangan
Tahun penerbitan	2020 hingga 2024	Sebelum tahun 2020
Bahasa	Bahasa Melayu dan Bahasa Inggeris	Selain daripada Bahasa Melayu dan Bahasa Inggeris

Kelayakan

Dalam **Fasa 3: Penilaian kelayakan artikel/jurnal terpilih**, pengkaji telah menyaring artikel yang sesuai agar relevan dengan objektif dan kata kunci kajian. Berdasarkan proses penapisan yang dijalankan, sejumlah 403 artikel telah dikecualikan dalam fasa kelayakan ini. Sehubungan itu, 30 artikel telah dikenal pasti untuk dimasukkan dalam kajian tinjauan literatur sistematik ini kerana benar-benar relevan dengan objektif dan persoalan kajian.

Termasuk

Rajah 2 menunjukkan proses yang dijalankan dalam pemilihan artikel berdasarkan empat (4) fasa dalam model PRISMA. Artikel-artikel ini diperoleh melalui tiga pangkalan data iaitu *Scopus, MyJurnal* dan *Google Scholar.* Pengkaji telah memuat turun 30 artikel yang layak untuk dibincangkan kerana kerelevanan dengan objektif dan kandungan kajian.



Rajah 2: Carta alir proses pemilihan artikel berdasarkan model PRISMA
(Sumber: Page et al., 2021)

3. Hasil Kajian

3.1 Trend penyelididkan penggunaan Canva sebagai media interaktif dalam PdP abad ke-21

Jadual 3 menunjukan maklumat penemuan 30 artikel yang telah dipilih untuk kajian ini. Menerusi Jadual 3, trend penyelidikan dinyatakan secara ringkas berdasarkan kesesuaian artikel kajian keberkesanan penggunaan aplikasi *Canva* sebagai media interaktif dalam pengajaran dan pembelajaran (PdP) abad ke-21.

Jadual 3: Trend penyelidikan mengikut tahun penerbitan, reka bentuk kajian, negara, dan instrumen.

No	Nama penulis	Tajuk kajian	Reka bentuk kajian	Negara	Instrumen
1	Mahardika et al., 2021	Pembuatan Media Pembelajaran Menarik Menggunakan Canva untuk Optimalisasi Pembelajaran Daring	Kualitatif	Indonesia	Pemerhatian Temu bual
2	Mudinillah & Rizaldi, 2021	*Using the Canva Application as an Arabic Learning Media at SMA Plus Panyabungan*	Kualitatif	Indonesia	Penelitian literatur
3	Rahmawati & Atmojo, 2021	Analisis Media Digital Video Pembelajaran Abad 21 Menggunakan Aplikasi Canva pada Pembelajaran IPA	Kualitatif	Indonesia	Temu bual
4	Fitria, 2022	*Using Canva as Media for English Language Teaching (ELT): Developing Creativity for Informatics Students*	Kualitatif	Indonesia	Pemerhatian
5	Mulyati et al., 2022	*Development of Canva Application-Assisted Learning Media in Class XII Advanced Study Materials with 4-D Models*	Kuantitatif	Indonesia	Soal selidik
6	Nurja et al., 2022	*The Use of Canva as Learning Medium of MPU12012 Entrepreneurship*	Kuantitatif Kualitataif	Malaysia	Pemerhatian Soal selidik
7	Pulungan et al., 2022	Pembuatan Media Pembelajaran Interaktif Canva Bersama Guru Yayasan Harum Sentosa Sebagai Upaya Meningkatkan Minat Belajar Siswa	Kualitatif	Indonesia	Pemerhatian
8	Fauziah et al., 2022	Implementasi Media Pembelajaran Interaktif Berbasis Aplikasi Canva pada Mata Pelajaran Sejarah Kebudayaan Islam	Kualitatif	Indonesia	Pemerhatian Temubual
9	Harpiani et al., 2022	Pengembangan E-Modul Bahan Ajar Berbasis Aplikasi Canva	Kuantitatif	Indonesia	Soal selidik
10	Ilham et al., 2022	*Use of Canva Application as a Learning Media*	Kualitatif	Indonesia	Penelitian literatur
11	Ebe et al., 2022	*The Implementation Of "Canva" As Media To Increase Student's Interest in Learning*	Kuantitatif	Filipina	Soal selidik
12	Wijayanti, 2022	*Teaching English by Using Canva: Students' and Lecturers' Voice*	Kuantitatif	Indonesia	Soal selidik
13	Musannadah & Jannah, 2022	*The Application of Canva as Interactive Media in 21st-Century Learning*	Kualitatif	Indonesia	Penelitian literatur
14	Titiyanti et al., 2022	*Implementing Canva in the Digital Learning Process for Junior High School*	Kualitatif	Indonesia	Pemerhatian Temu bual
15	Putra & Filianti, 2022	Pemanfaatan *Canva For Education* Sebagai Media Pembelajaran Kreatif dan kolaboratif untuk Pembelajaran Jarak Jauh	Kualitatif Kuantitatif	Indonesia	Pemerhatian Temu bual Soal selidik
16	Hinchcliff & Mehmet, 2023	*Embedding Canva into the marketing classroom: a dialogic and social learning approach to classroom innovation*	Kualitatif	Australia	Pemerhatian Temu bual
17	Munasiah et al., 2023	Pemanfaatan Aplikasi Canva dalam Membuat Media Pembelajaran	Kualitatif	Indonesia	Pemerhatian
18	Ledentsov et al., 2023	*Basic Electricity and Electronics Subjects using Canva as a Learning Medium*	Kuantitatif	Indonesia	Soal selidik
19	Kuek et al., 2023	Analisis Keperluan E-Modul Perisian Canva	Kuantitatif	Malaysia	Soal selidik

No	Nama penulis	Tajuk kajian	Reka bentuk kajian	Negara	Instrumen
		dalam Mata Pelajaran Pendidikan Seni Visual dalam Kalangan Guru Sekolah Rendah			
20	Rajendran et al., 2023	*A Critical Review on Using Canva as a Visual Media Platform for English Language Learning*	Kualitatif	Malaysia	Penelitian literatur
21	Enramika et al., 2023	*Development of Canva Application-Based Arabic Learning Media to Improve The Skills of 21st-Century Educators*	Kualitatif	Indonesia	Penelitian literatur
22	Paramitha et al., 2023	Pengembangan Multimedia Interaktif Berbasis Aplikasi Canva Pada Materi Sistem Pernapasan	Kualitatif	Indonesia	Pemerhatian Temu bual
23	Hadana et al., 2023	Implementasi Media Canva pada Pembelajaran Bahasa Indonesia Teks Negosiasi Kelas X SMA Negeri 11 Semarang	Kualitatif	Indonesia	Pemerhatian Temu bual
24	Citradevi, 2023	Canva sebagai Media Pembelajaran pada Mata Pelajaran IPA:Seberapa Efektif? Sebuah Studi Literatur	Kualitatif	Indonesia	Penelitian literatur
25	Nasution et al., 2023	*The Influence of Canva Application Learning Media and Learning Motivation on Students' Islamic Religious Education Learning Outcomes at Panca Budi Elementary School, Medan*	Kuantitatif	Indonesia	Soal selidik
26	Kocaarslan & Eryaman, 2024	*Using "Canva For Education" Application with Collaborative Learning in Visual Arts Lesson: Sample Activities for Teachers*	Kualitatif	Turkey	Pemerhatian
27	Ahamad, 2024	Pendekatan Tematik Melalui Penggunaan Canva dalam Pengajaran dan Pembelajaran Bahasa Melayu	Kualitatif	Malaysia	Temu bual
28	Aluintany & Bektiningsih, 2024	*Interactive Game Learning Media Based on Canva on Five Sensory Materials for Grade IV Elementary School*	Kualitatif	Indonesia	Penelitian literatur
29	Putriani et al., 2024	*Exploration of New Learning Media: Canva as a Medium for Brand Logo Design for Vocational Students*	Kualitatif	Indonesia	Penelitian literatur
30	Alamia & Hamid, 2024	*Canva-Based Learning Media: Students Learning Outcomes in Senior High School*	Kualitatif	Indonesia	Pemerhatian Temu bual

3.2 Latar Belakang Artikel

Tahun Penerbitan

Analisis kajian ini melibatkan artikel dan jurnal yang telah diterbitkan antara tahun 2020 hingga 2024. Apabila dilihat daripada aspek trend tentang kajian berkaitan penggunaan *Canva* sebagai media interaktif dalam PdP semakin meingkat dari tahun 2021 hingga kini (2024). Hal ini disebabkan ketika global dilanda pandemik Covid-19 pada tahun 2020, pelaksanaan pembelajaran atas talian semakin meningkat. Pelbagai platform dalam talian telah digunakan secara optimum sebagai alternatif pelaksanaan PdP untuk menggantikan kaedah pembelajaran secara bersemuka (Abdullah & Zin, 2022). Berdasarkan Jadual 3, terdapat tiga kajian pada tahun 2021 (Mahardika et al., 2021; Mudinillah & Rizaldi, 2021; Rahmawati & Atmojo, 2021) dan 12 kajian pada tahun 2022 iaitu (Fitria, 2022; Mulyati et al., 2022; Nurja et al., 2022; Pulungan et al., 2022; Fauziah et al., 2022; Harpiani et al., 2022; Ilham et al., 2022; Ebe et al., 2022; Wijayanti, 2022; Musannadah & Jannah, 2022; Titiyanti et al., 2022; Putra & Filianti, 2022). Seterusnya pada tahun 2023, terdapat 10 kajian iaitu (Hinchcliff & Mehmet, 2023; Munasiah et al., 2023; Ledentsov et al., 2023; Kuek et al., 2023; Rajendran et al., 2023; Enramika et al., 2023; Paramitha et al., 2023; Hadana et al., 2023; Citradevi, 2023; Nasution et al., 2023) dan sebanyak 5 kajian pada tahun 2024 (Kocaarslan & Eryaman, 2024; Ahamad, 2024; Aluintany & Bektiningsih, 2024; Putriani et

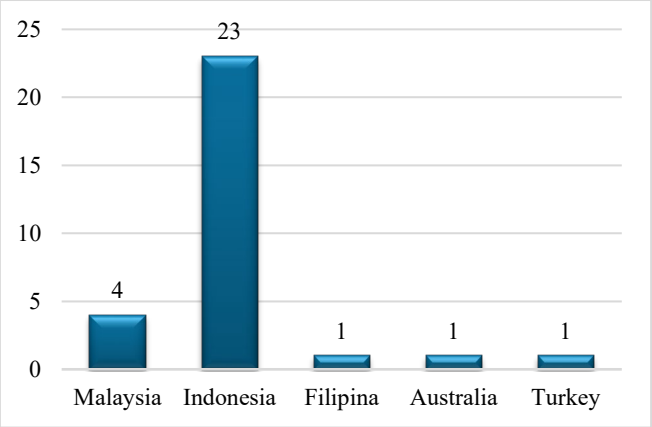
al., 2024; Alamia & Hamid, 2024).

Reka Bentuk Kajian

Kajian-kajian yang dilaksanakan mengaplikasi pendekatan kuantitatif, kualitatif dan *mixed mode* iaitu menggunakan reka bentuk kuantitatif serta kualitatif dalam satu kajian yang sama. Berdasarkan Jadual 3, terdapat 7 kajian menggunakan reka bentuk kuantitatif iaitu (Mulyati et al., 2022; Harpiani et al., 2022; Ebe et al., 2022; Wijayanti, 2022; Ledentsov et al., 2023; Kuek et al., 2023; Nasution et al., 2023). Seterunya, sejumlah 21 kajian berlandaskan reka bentuk kualitatif (Mahardika et al., 2021; Mudinillah & Rizaldi, 2021; Rahmawati & Atmojo, 2021; Fitria, 2022; Pulungan et al., 2022; Fauziah et al., 2022; Ilham et al., 2022; Musannadah & Jannah, 2022; Titiyanti et al., 2022; Hinchcliff & Mehmet, 2023; Munasiah et al., 2023; Rajendran et al., 2023; Enramika et al., 2023; Paramitha et al., 2023; Hadana et al., 2023; Citradevi, 2023; Kocaarslan & Eryaman, 2024; Ahamad, 2024; Aluintany & Bektiningsih, 2024; Putriani et al., 2024; Alamia & Hamid, 2024) dan sebanyak 2 kajian dijalankan secara *mixed mode* (Nurja et al., 2022; Putra & Filianti, 2022).

Negara Penerbitan

Rajah 3 menunjukkan hasil analisis terhadap 30 artikel mengikut negara penerbitan yang melibatkan negara Malaysia, Indonesia, Filipina, Australia dan Turkey.



Rajah 3: Senarai penerbitan mengikut negara

Instrumen Kajian

Hasil analisis kajian mendapati bahawa para pengkaji menggunakan instrument pemerhatian, temu bual, soal selidik dan penelitian literatur dalam pengumpulan data kajian. Berpandukan Jadual 3, terdapat 7 menggunakan instrumen pemerhatian beserta temu bual (Mahardika et al., 2021; Fauziah et al., 2022; Titiyanti et al., 2022; Hinchcliff & Mehmet, 2023; Hadana et al., 2023; Paramitha et al., 2023; Alamia & Hamid, 2024), satu kajian mengaplikasi instrumen pemerhatian dan soal selidik (Nurja et al., 2022) dan satu kajian menggunakan kombinasi instrumen pemerhatian, temu bual serta soal selidik iaitu (Putra & Filianti, 2022). Selanjutnya, 2 kajian menggunakan instrumen temubual iaitu (Rahmawati & Atmojo, 2021; Ahamad, 2024), sebanyak 4 kajian dikenal pasti menggunakan instrumen pemerhatian (Fitria, 2022; Pulungan et al., 2022; Munasiah et al., 2023; Kocaarslan & Eryaman, 2024) dan sejumlah 7 kajian menggunakan instrumen soal selidik (Mulyati et al., 2022; Harpiani et al., 2022; Ebe et al., 2022; Wijayanti, 2022; Ledentsov et al., 2023; Kuek

et al., 2023; Nasution et al., 2023).

3.3 Impak atau keberkesanan penggunaan Canva sebagai media interaktif dalam PdP abad ke-21

Seterusnya, persoalan kedua dalam kajian ini akan dianalisis berdasarkan impak atau keberkesanan penggunaan *Canva* sebagai media interaktif dalam PdP abad ke-21. Jadual 4 menunjukkan hasil kajian yang telah dianalisis berhubung keberkesanan aplikasi *Canva* yang berperanan sebagai media interaktif untuk mencapai dan meningkatkan hasil pembelajaran.

Jadual 4: Keberkesanan *Canva* sebagai media interaktif dalam PdP

Penulis (Tahun)	Hasil Analisis
Mulyati et al., 2022; Pulungan et al., 2022; Kocaarslan & Eryaman, 2024; Mahardika et al., 2021; Mudinillah & Rizaldi, 2021; Rahmawati & Atmojo, 2021; Fitria, 2022; Nurja et al., 2022; Harpiani et al., 2022; Ilham et al., 2022; Musannadah & Jannah, 2022; Hinchcliff & Mehmet, 2023; Ledentsov et al., 2023; Kuek et al., 2023; Rajendran et al., 2023; Ahamad, 2024	• Alat bantu mengajar yang dibangunkan menggunakan aplikasi *Canva* memudahkah para pelajar. Media PdP yang digunakan berupaya meningkatkan tahap kefahaman pelajar dalam topik pembelajaran. • Penggunaan *Canva* sebagai media pembelajaran mendapat sambutan yang positif responden. Hal ini dapat dilihat dengan peningkatan markah penilaian pelajar. • *Canva For Education* merupakan alat digital yang berkesan untuk pendidik dan pelajar kerana reka bentuk yang menarik, mesra pengguna, mudah akses dan mendorong kreativiti serta kolaboratif dalam kurikulum pembelajaran. • Pelajar memahami media pembelajaran dengan baik sekiranya media pembelajaran yang digunakan menarik dan interaktif. Aplikasi *Canva* merupakan alat multimedia yang menggabungkan deria manusia bagi memudahkan pencapaian kompetensi dan kefahaman pelajar. • Salah satu faktor yang menentukan kejayaan sesuatu proses pembelajaran ialah bagaimana media pengajaran yang digunakan cukup menarik untuk menarik perhatian pelajar untuk fokus semasa proses pengajaran dan pembelajaran. • Ciri-ciri interaktif pada aplikasi *Canva* mendorong pelajar untuk mengambil bahagian secara aktif dalam pembelajaran dan mencipta karya yang menarik.
Fauziah et al., 2022; Ebe et al., 2022; Wijayanti, 2022; Titiyanti et al., 2022; Putra & Filianti, 2022; Munasiah et al., 2023; Hadana et al., 2023	• Pelaksanaan *Canva* sebagai media interaktif PdP menjadikan pelajar lebih bersemangat dalam pembelajaran. • Pelajar kelihatan tenang apabila menggunakan media interaktif berasaskan *Canva* ini, walaupun sesekali bertanyakan jika ada yang kurang faham mengenai penggunaannya. • Aplikasi *Canva* menyediakan templat yang boleh digunakan untuk video pembelajaran, membuat slaid pembentangan, komik, brosur, slogan yang tentunya sangat membantu pensyarah atau guru dalam menyediakan atau menyampaikan bahan yang baik dan mudah difahami pelajar supaya pelajar dapat menyerap bahan tersebut dengan mudah. • Melalui *Canva for Education*, pensyarah atau guru berupaya unutk mereka bentuk persembahan pengajaran dan menghasilkan video interaktif. • *Canva* meningkatkan literasi digital dan kreativiti dalam aspek pengajaran dan pembelajaran pensyarah atau guru.
Enramika et al., 2023; Paramitha et al., 2023; Citradevi, 2023; Nasution et al., 2023; Ahamad, 2024; Aluintany & Bektiningsih, 2024; Putriani et al., 2024; Alamia & Hamid, 2024	• *Canva* boleh menjadikan pembelajaran visual, komunikasi mudah, menyeronokkan dan boleh membangunkan kreativiti serta kemahiran kolaboratif. • Media interaktif berasaskan *Canva* ini dibangunkan dengan tujuan

Penulis (Tahun)	Hasil Analisis
	untuk memudahkan dan kesesuaian dengan keadaan semasa pelajar. • Penggunaan media interaktif dalam PdP memberi impak yang baik, memudahkan pelajar dalam proses pembelajaran dan dapat menarik perhatian pelajar dalam menyertai aktiviti pembelajaran yang dijalankan. • Di samping itu, penilaian penggunaan media interaktif juga dijalankan dengan melakukan beberapa penambahbaikan supaya aplikasi *Canva* sebagai alat bantu mengajar PdP sesuai untuk dilaksanakan. • Media pembelajaran interaktif berasaskan *Canva* terbukti boleh diaplikasikan dan berkesan dalam menjalankan proses pembelajaran. • Penggunaan *Canva* sebagai medium pembelajaran dapat membantu pelajar memahami bahan pengajaran yang disampaikan.

4. Perbincangan

Artikel-artikel kajian yang telah dianalisis memberi suatu makna bahawa penggunaan *Canva* sebagai media interaktif dalam PdP abad ke-21 adalah sangat relevan dan secara tidak langsung hasil kajian ini menyokong penemuan penyelidikan terdahulu. Dapat dilihat di sini bahawa penggunaan media pembelajaran berasaskan *Canva* memberi manfaat dalam meningkatkan daya minat dan menghilangkan kebosanan dalam kalangan pelajar semasa aktiviti pembelajaran. Hasilnya, ini boleh menjadikan pelajar bermotivasi dan hasil pembelajaran pelajar juga akan meningkat (Kaharuddin et al., 2023; Nailiah & Saputra, 2022; Riono & Fauzi, 2022; Aluintany & Bektiningsih, 2024). Hal ini sejajar dengan Al Hidayah et al., (2024) yang menjelaskan bahawa *Canva* dapat meningkatkan minat pelajar dalam menjalankan aktiviti PdP dan membangkitkan motivasi pelajar melalui penyampaian media pembelajaran yang menarik.

Berdasarkan hasil kajian, negara Asia seperti Indonesia dan Malaysia mempunyai bilangan kajian berkaitan keberkesanan penggunaan *Canva* sebagai media interaktif PdP berbanding negara lain. Hal ini berlaku disebabkan Pembelajaran Abad ke-21 (PAK-21) dan Pelan Pembangunan Pendidikan Malaysia 2013-2025, salah satu elemen yang ditekankan di peringkat sekolah ialah penggunaan media teknologi (Kuek et al., 2023). Lantaran itu, pengintegrasian teknologi maklumat dan komunikasi (TMK) dalam mata pelajaran dapat membatu para pendidik unutk meningkatkan impak PdP. Penghasilan media pembelajaran yang interaktif akan mewujudkan proses pembelajaran yang lebih menyeronokkan dan efektif. Malah, media interaktif yang berasaskan teknologi seperti *Canva* berupaya unutk membina pengetahuan kendiri tentang reka bentuk grafik untuk menghasilkan media atau model pembelajaran (Mustafa & Roesdiyanto, 2021; Kuek et al., 2024).

Seterusnya, hasil analisis mendapati majoriti pendekatan atau reka bentuk penyelidikan yang digunakan ialah kualitatif berbanding kuantitatif dan gabungan (mixed mode). Kajian berbentuk kualitatif merupakan penyelidikan yang bersifat deskriptif dan cenderung menggunakan analisis mendalam (Kaharuddin, 2021). Selain itu, proses dan makna (perspektif subjek) lebih ditekankan dalam penyelidikan kualitatif. Asas teori dijadikan panduan supaya fokus kajian bersesuaian dengan fakta padang. Kualitatif juga ditafsirkan sebagai penyelidikan yang membawa kepada penilaian terhadap latar belakang sifat pelbagai peristiwa sosial yang berlaku. Selain itu, kualitatif ditakrifkan sebagai laluan untuk menemui dan menerangkan sesuatu peristiwa secara naratif (Denzin & Lincoln, 1994; Nazir, 2005; Somantri, 2005 dan Creswell, 2010; Kaharuddin, 2021). Namun begitu, kajian kuantitatf juga berupaya untuk

melihat perbezaan dan mampu membandingkan impak sesuatu intervensi dengan lebih jelas menerusi skor (Creswell & Creswell, 2018; Ramaya & Maat, 2022).

5. Kesimpulan

Akhir sekali, berdasarkan analisis literatur sistematik ini, dapat dirumuskan bahawa penggunaan media pembelajaran interaktif berasaskan reka bentuk grafik melalui aplikasi *Canva* merupakan impak positif yang boleh digunakan untuk memenuhi kompetensi pelajar. Media pembelajaran mesti direka untuk memudahkan pembelajaran pelajar. Media pembelajaran merupakan alat untuk membantu pensyarah atau guru menyampaikan topik pembelajaran kepada pelajar. Oleh itu, dengan penggunaan aplikasi *Canva* sebagai media interaktif pengajaran dan pembelajaran abad ke-21 ini, ia berupaya memudahcara para pendidik untuk peningkatan motivasi, literasi saintifik dan pencapaian hasil pembelajaran pelajar dalam meningkatkan kemampuan belajar menjadi lebih baik.

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The Influence of ChatGPT on Students' English Language Presentation Skills

Vun Jing Shu[1]

[1]General Studies Unit, Kolej Komuniti Penampang

vun@kkpenampang.edu.my

Abstract

ChatGPT has been widely used among students as a tool to get ideas and answers for self-study. Therefore, the objective of this study is a) to identify the main purpose of using ChatGPT, b) the level of dependence on using ChatGPT for presentations in English classes, and c) the impact of dependency on ChatGPT on improving the students' level of skills in making English presentations. The study sample is 105 students from Kolej Komuniti Penampang Sabah. This study uses a random sampling technique distributed online. The data that has been collected was statistically analysed using descriptive analysis to obtain the mean score value and linear regression to analyse the relationship between variables, using the SPSS software. The results of the study showed that the most important purpose of using ChatGPT is to find important content in the presentation (55.2 percent). The study findings also showed that the level of dependence of students was low. Meanwhile, in terms of the effects of ChatGPT, on average, most students agree that ChatGPT helps them in making presentations in English. This study is important in helping students explore more functions in ChatGPT to help them with their English presentations.

Keywords: *ChatGPT, English language, presentation skills*

Introduction

ChatGPT technology is increasingly popular among students for learning purposes (Mahmood et al., 2024) and also among students in Higher Education Institutions (Dempere et al., 2023), raising concerns about over-reliance on this AI tool (Sulehri et al., 2025). On the positive side, according to Ariffin (2023), ChatGPT can help students understand and complete student work by answering questions, providing explanations, and generating example problems or solutions. It can also help students improve their language and writing skills by providing feedback on grammar, vocabulary, and style, as well as by helping them generate and edit written content. ChatGPT can also help students learned on their own by providing personalized content and guidance based on their interests and level of understanding. In addition, many studies explained the various advantages of ChatGPT to learning as described in findings such as Lo (2023), impact of ChatGPT on learning motivation (Ali et al., 2023), impact of ChatGPT on foreign language teaching and learning (Hong, 2023), effect of Chat GPT on the digitized learning process (Castillo et al., 2023).

Based on the advantages of ChatGPT for learning, research needs to be conducted to identify whether this artificial intelligence (AI) technology can help students improve their presentation skills. This is because AI is usually used by students to get ideas in writing, as described in many studies (Mahapatra, 2024; Polakova & Ivenz, 2024; Yan, 2023) or to get answers to complex questions (Pichappan et al., 2023; Shoufan, 2023; Lai, 2023). Therefore, to find an answer to this question, this survey was conducted on students of Kolej Komuniti Penampang, Sabah, to identify the extent to which ChatGPT helps them in improving their presentation skills in English classes. This study chose this group of students because they

generally have weaknesses in English, so they likely use ChatGPT to guide them, just as they look for solutions for other subjects. This study is important to assess the extent to which students' behaviour in trying to improve their English skills through various means, such as the use of ChatGPT.

Study Objectives

This study was conducted to:

a) Identify the main purpose on using ChatGPT in improving presentation skills in English among the students at KK Penampang, Sabah.
b) Identify the level of dependency on using ChatGPT for Presentations in English Classes among the students at KK Penampang, Sabah.
c) Identify the impact of dependency of ChatGPT on improving the students' level of skills in making English presentations among the students at KK Penampang, Sabah

Literature Reviews

ChatGPT is increasingly becoming an attractive tool in the context of English language learning and the development of presentation skills among students. In the context of English presentation skills, Khup and Bantugan (2025) argue that Artificial Intelligence (AI) can improve writing efficiency among junior secondary school students. This is because AI helps to increase creativity and understanding of the subject, which are important prerequisites for effective presentations. This relationship can be supported by the Technology Acceptance Model (TAM) (Davis, 1989), which is relevant because it explains students' intentions to use ChatGPT based on the extent to which they consider it useful and easy to use for skill improvement. In addition, Self-Determination Theory (SDT) (Deci & Ryan, 2000) also explains why students are intrinsically motivated to use it, especially if the use of ChatGPT increases their sense of autonomy (learning control) and competence (sense of effectiveness). The findings of a study by Decano and Galicia (2025) on senior high school students found that students experienced an improvement in linguistic communication and writing skills with the help of ChatGPT. Similarly, a study by Lee (2024) explained that ChatGPT fosters a positive learning experience and motivates students in English writing education. According to Zakarneh et al. (2025), ChatGPT has transformative potential in language education and helps students achieve better educational outcomes. Shahsavar et al. (2024) showed that AI supports a balanced approach and complements traditional teaching methods. This is evidenced by studies showing that students have positive perceptions of using ChatGPT, including its ability to improve vocabulary acquisition and grammatical understanding (Irianto et al., 2024; Par et al., 2024). This is very important, as enhanced vocabulary and grammar directly contribute to improved presentation skills, enabling students to communicate more effectively and dynamically engage with their audiences. Furthermore, regular interaction with ChatGPT correlates with improved grammar skills and increased student engagement, which is essential for effective presentations (Xu et al., 2024; Zhang, 2025).

Research Methodology

This study employed quantitative methods and was conducted at Kolej Komuniti Penampang Sabah. Respondents consisted of 105 students taking the Certificate in Architectural Technology and the Certificate in Business Operations who answered the questionnaire conducted online. This study used a simple random sampling technique that was distributed online. The study items were self-constructed based on a review of past studies related to the use of ChatGPT in learning. The research items were reviewed by several lecturers who are experts in research, including lecturers holding a PhD. The study items underwent item reliability testing, where the Cronbach alpha value obtained was 0.941 for five items of reliance on the use of ChatGPT for Presentations in English Classes; and 0.921 for 7 items of the impact of reliance on ChatGPT to improve students' skills in making English presentations. This value indicates a high level of item reliability and is suitable for use among students. The data that was collected was statistically analysed using descriptive analysis to obtain a mean score value and linear regression to analyse the relationship between variables. The mean value will be translated to the following, as used in the study by Ngadiman et al. (2019): 1.00– 1.99 (Poor); 2.00– 2.99 (Low); 3.00– 3.99 (Moderate); 4.00– 5.00 (High).

Study Results

a) Respondent Demographics

Item		n	%
Gender	Male	44	41.9
	Female	61	58.1
Programme	Sijil Pengoperasian Perniagaan	47	44.8
	Sijil Teknologi Senibina	58	55.2
Semester	1	39	37.1
	2	15	14.3
	3	47	44.8
	4	4	3.8
CGPA	1.00 and below	1	1.0
	1.01 - 2.00	1	1.0
	2.01 - 3.00	4	3.8
	3.01 - 4.00	62	59.0
	No CGPA (Semester 1)	37	35.2

Table 1 shows the background of the respondents. A total of 105 respondents were involved in this study. They consisted of 58.1 percent female students and 41.9 percent male students. Many respondents were from semester 3 (44.8 percent) and from the Certificate in Architectural Technology program (55.2 percent), and the rest were from the Certificate in

Business Operations program (44.8 percent). In terms of CGPA, the majority had a good result level, which was between 3.01 and 4.00 (59 percent).

b) Identify the main purpose of using ChatGPT in improving presentation skills in English.

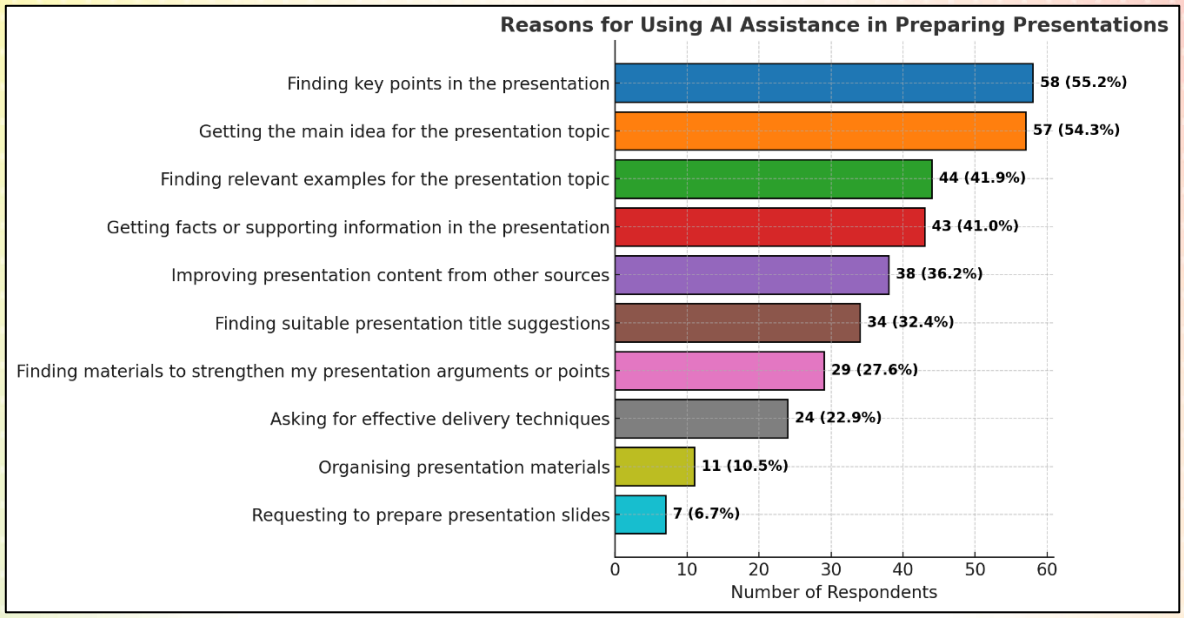


Figure 1: Reasons to Use AI for English Class Presentations

Figure 1 shows the findings for objective 1, which is to identify the purpose of using ChatGPT among students to help them in their presentations for English classes. For this section, the study data are in nominal form. Respondents selected items without identifying the level. Respondents could select a maximum of three main purposes for using ChatGPT to help them in their presentations. The most important purpose for using ChatGPT was to find important content in the presentation (55.2 percent), followed by the purpose of getting the main idea of the presentation topic (54.3 percent) and the purpose of finding relevant examples for the presentation topic (41.9 percent).

c) Identify the level of dependency on using ChatGPT for Presentations in English Classes

Table 2: Level of Dependency of Using ChatGPT

No	Item	Mean	Std. Dev	Level
G1	I use ChatGPT almost every time I prepare a presentation	2.895	1.055	Low
G2	I rely on ChatGPT to obtain the main content of my presentation	2.829	1.069	Low
G3	I use ChatGPT whenever I need to find new ideas for my presentation	3.114	1.041	Moderate

G4	I find it difficult to complete a presentation without using ChatGPT	2.657	1.134	Low
G5	I often make ChatGPT my main reference source when preparing presentations	3.019	1.109	Moderate
	Average	*2.903*	*1.082*	*Low*

Table 2 shows the findings for the second study objective, which is to identify the level of dependency on using ChatGPT for Presentations in English Classes. On average, the level of dependency of students is low. This shows that they use ChatGPT assistance to help in English class presentations, but not too often. The item that obtained the highest mean is item G3, which is students use ChatGPT every time they need to find new ideas for presentations (mean 3.114), followed by item G5, which is students often make ChatGPT the main reference source in preparing presentations (mean 3.019). The low level in this study is in line with the findings of studies that show that students use ChatGPT to get ideas in writing (Mahapatra, 2024; Polakova & Ivenz, 2024; Yan, 2023) or get answers to complex questions (Pichappan et al., 2023; Shoufan, 2023; Lai, 2023), not focusing on assistance for presentations.

d) Identify the impact of the dependency on ChatGPT on improving the students' level of skills in making English presentations

Table 3: Descriptive analysis of the Impact of ChatGPT in English Class Presentations.

No	Item	Mean	Level
K1	I can present my ideas in English clearly and in an organized manner	3.076	Moderate
K2	I am confident when giving a presentation in English	3.038	Moderate
K3	I use visual aids, such as PowerPoint slides, effectively to support my English presentation	3.152	Moderate
K4	I can confidently answer questions in English from the lecturer and students	3.038	Moderate
K5	I can present fluently in English using content prepared with the help of ChatGPT	2.914	Low
K6	I often have difficulty using correct English grammar during my presentation	2.771	Low
K7	I often cannot pronounce certain English words clearly during my presentation	2.724	Low
	Average	*2.959*	*Low*

In these results, the analysis for objective three was divided into descriptive analysis and linear regression analysis. For descriptive analysis, the impact of using ChatGPT was based only on student feedback without connecting it with their dependency on ChatGPT. Based on

the results in Table 3, most students agreed that ChatGPT helped them in making presentations in English. This was evidenced by the majority agreeing on items K1, K2, K3, and K4. The negative items, namely K6 and K7, showed a low level of agreement from the respondents. On average, these findings indicate that the use of ChatGPT can help them in English class presentations.

Table 4: Liner regression analysis of SPSS

IV	DV	Std. Error	Beta	t	Sig.	R^2
(Constant)		0.174		4.375	0.000	0.631
Dependency of using ChatGPT	Impact of ChatGPT in English Class Presentations	0.057	0.795	13.28	0.000	

Meanwhile, for the regression analysis, the result in Table 4 shows the relationship between the dependency of ChatGPT on improving the students' level of skills in making English presentations. This result explains that the more often students use ChatGPT, the better the aspect of student presentation in English. These findings also explain that although no item obtained a high level, at least students strive to improve their English presentation skills through self-study using ChatGPT. The findings of this study are in line with many studies that explain the benefits of ChatGPT for learning, such as discussions on potential benefits of ChatGPT in promoting teaching and learning (Baidoo-Anu & Ansah, 2023), A revolutionary tool for teaching and learning mathematics (Wardat et al., 2023), and How Can ChatGPT Facilitate Teaching and Learning (Karakose & Tülübas, 2023). R Square (0.631) means that 63.1% of the variation in the Impact of ChatGPT in English Class Presentations (DV) can be explained by the Dependency of using ChatGPT (IV) in the regression model. This indicates a strong relationship, showing that students' level of dependency on ChatGPT contributes significantly to predicting how much ChatGPT influences their English presentations. The remaining 36.9% of the variation is affected by other factors not included in the model.

Discussion and Conclusion

This study explored the influence of ChatGPT on students' English language presentation skills at Kolej Komuniti Penampang, Sabah. The findings revealed that students primarily use ChatGPT to find important content, grasp the main ideas, and obtain relevant examples for their presentations. Despite this, the level of dependency on ChatGPT among students was generally low, indicating that students use it as a supplementary tool rather than relying on it entirely. Hence, descriptive analysis showed that ChatGPT positively impacts students' presentation abilities, particularly in organizing ideas, building confidence, effectively using visual aids, and responding to questions in English. However, areas such as grammar accuracy, pronunciation, and fluency still showed lower improvements, suggesting that ChatGPT alone cannot fully resolve these challenges. Regression analysis confirmed a significant positive relationship between the frequency of ChatGPT use and improvement in presentation skills, highlighting its potential as a supportive learning tool.

The implications of this study suggest that integrating ChatGPT into English learning can enhance students' self-directed learning, provide guidance in preparing presentations, and

strengthen their overall communication skills. Lecturers can encourage students to use ChatGPT as a complementary tool, while also focusing on interactive practice to address gaps in grammar, pronunciation, and fluency. Future studies could expand the sample size, include other institutions, and explore additional AI tools to further understand the role of technology in developing language and presentation competencies. Overall, this study emphasizes the value of ChatGPT in empowering students to improve their English presentation skills, while promoting responsible and balanced use of AI in education.

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HUBUNGAN SOLAT DAN AMALAN SUNNAH DENGAN PENCAPAIAN AKADEMIK PELAJAR JABATAN KEJURUTERAAN ELEKTRIK, POLITEKNIK SULTAN IDRIS SHAH : SATU KAJIAN KES

Noorwati Mohd Dawam[1*], Mohd Fadzli Zulkeflee[2], Robiah Zakaria[3]

[123]Jabatan Pengajian Am, Jabatan Hal Ehwal Pelajar, Jabatan Kejuruteraan Elektrik,
Politeknik Sultan Idris Shah, Selangor

*noorwati.dawam@psis.edu.my. fadzlizulkeflee@psis.edu.my, robiah_zakaria@psis.edu.my

ABSTRAK

Kajian ini dijalankan untuk meneliti hubungan antara amalan solat fardu serta amalan sunnah dengan pencapaian akademik pelajar di Jabatan Kejuruteraan Elektrik, Politeknik Sultan Idris Shah. Objektif utama kajian adalah mengenal pasti tahap pengamalan solat fardu dan sunnah serta menilai perkaitannya dengan prestasi akademik pelajar. Seramai 119 orang pelajar telah dipilih sebagai responden melalui kaedah persampelan rawak mudah. Instrumen soal selidik digunakan dalam pengumpulan data, manakala analisis data dijalankan menggunakan perisian SPSS versi 26.0. Bagi menentukan kekuatan serta arah hubungan antara pemboleh ubah kajian, ujian Korelasi Pearson telah diaplikasikan.Dapatan kajian menunjukkan wujud hubungan yang kuat dan signifikan antara amalan solat fardu dan amalan sunnah dengan nilai pekali korelasi $r = 0.769$, $p = 0.000$ ($p < 0.01$). Ini menjelaskan bahawa pelajar yang konsisten menunaikan solat fardu juga lebih cenderung mengamalkan amalan sunnah dalam kehidupan seharian. Walau bagaimanapun, analisis turut mendapati tiada hubungan signifikan antara amalan solat fardu dengan pencapaian akademik ($r = -0.073$, $p = 0.471$) serta antara amalan sunnah dengan pencapaian akademik ($r = -0.009$, $p = 0.931$).Kesimpulannya, walaupun tahap amalan keagamaan pelajar berada pada tahap tinggi dan saling berkait rapat, ia tidak memberi kesan langsung terhadap pencapaian akademik. Sebaliknya, amalan solat fardu dan sunnah dipercayai menyumbang kepada pembentukan sahsiah, pengukuhan disiplin diri, serta kesejahteraan emosi pelajar secara holistik.

Kata kunci: *Solat, Amalan Sunnah, Prestasi Akademik, Sahsiah, Pelajar Politeknik*

1. PENDAHULUAN

Kejayaan membentuk modal insan berdaya saing dan bermutu amat dipengaruhi oleh keberkesanan sistem pendidikan. Dalam konteks institusi pengajian tinggi, pencapaian akademik pelajar sering kali dijadikan penanda aras utama bagi kejayaan sesebuah institusi. Namun begitu, prestasi pelajar bukan sahaja ditentukan oleh faktor kognitif dan pendekatan pedagogi, tetapi juga berkait rapat dengan amalan keagamaan dan dimensi kerohanian (Elias et al., 2020; Zubairu & Sakariyau, 2020). Solat fardu dan amalan sunnah, sebagai tuntutan utama dalam kehidupan seorang Muslim, dipercayai mampu membentuk disiplin diri, kestabilan emosi, dan ketenangan jiwa yang berpotensi mempengaruhi prestasi individu.

Sehubungan dengan itu, kajian ini memberi tumpuan kepada hubungan antara pengamalan solat fardu serta amalan sunnah dengan prestasi akademik. Amalan ibadah yang konsisten dan penghayatan sunnah diyakini dapat membina motivasi dalaman dan keperibadian yang teguh dalam kalangan pelajar. Oleh yang demikian, kajian ini dilaksanakan untuk menilai tahap pengaruh amalan keagamaan terhadap prestasi akademik pelajar, yang dinilai melalui Purata Nilai Gred Kumulatif (PNGK).

2. PERNYATAAN MASALAH

Pencapaian akademik yang tinggi sering dijadikan penanda aras utama bagi kualiti graduan dan institusi pendidikan. Walaupun pelbagai faktor kognitif dan sosial telah dikenal pasti sebagai penyumbang kepada pencapaian ini, peranan faktor spiritual dan amalan keagamaan masih memerlukan penelitian yang lebih mendalam, terutamanya dalam konteks pendidikan kejuruteraan. Dalam kalangan pelajar Muslim, amalan solat fardu dan solat sunnah dipercayai dapat membentuk disiplin diri, kestabilan emosi, dan ketenangan jiwa yang secara tidak langsung boleh mempengaruhi prestasi akademik. Namun, masih wujud jurang kajian yang meneliti secara khusus hubungan amalan keagamaan ini dengan pencapaian akademik, khususnya dalam kalangan pelajar kejuruteraan di institusi politeknik tempatan.

Pencapaian akademik pelajar di Politeknik Sultan Idris Shah (PSIS) menunjukkan variasi yang ketara, dengan sebahagian pelajar mencapai tahap cemerlang, manakala sebahagian yang lain berada pada tahap sederhana atau kurang memuaskan. Keadaan ini menimbulkan persoalan kritikal:Adakah tahap pengamalan solat dan sunnah memberi pengaruh yang jelas terhadap prestasi akademik pelajar?

Oleh yang demikian, kajian ini dijalankan untuk menjawab soalan utama berikut: Apakah tahap pelaksanaan solat dan amalan sunnah mempunyai hubungan yang signifikan dengan prestasi akademik pelajar Jabatan Kejuruteraan Elektrik di PSIS? Kajian ini juga akan meneroka faktor-faktor yang mungkin menggalakkan atau menghalang pelajar daripada melaksanakan amalan ibadah ini secara konsisten, bagi memberikan pemahaman yang lebih komprehensif.

3. OBJEKTIF KAJIAN:

Kajian ini dijalankan untuk mengenal pasti hubungan antara solat fardu, amalan sunnah, dan pencapaian akademik pelajar di Jabatan Kejuruteraan Elektrik, Politeknik Sultan Idris Shah.

3.1 OBJEKTIF KHUSUS:

1. Menilai sejauh mana pelajar Jabatan Kejuruteraan Elektrik menunaikan solat fardu secara konsisten.
2. Mengkaji kekerapan serta bentuk amalan sunnah yang diamalkan oleh pelajar Jabatan Kejuruteraan Elektrik.
3. Mengetahui persepsi pelajar tentang hubungan solat fardu dan amalan sunnah dengan pencapaian akademik.
4. Mengenal pasti hubungan amalan solat fardu dan amalan sunnah dengan pencapaian akademik pelajar JKE.

3.2 KEPENTINGAN KAJIAN

1. **Kepada pelajar:**

    1.1. Memberi kesedaran tentang kepentingan solat dan amalan sunnah bukan sahaja dari sudut rohani, malah sebagai faktor yang menyumbang kepada kejayaan akademik.

1.2. Mendorong pelajar membina disiplin diri, mengurus masa dengan baik, serta meningkatkan motivasi belajar.

2. Kepada pensyarah dan pihak jabatan:

2.1. Menjadi panduan dalam merangka aktiviti pembangunan sahsiah pelajar yang bersepadu dengan aspek akademik.

2.2. Membantu dalam usaha membentuk graduan seimbang dari segi ilmu,kemahiran, dan akhlak.

3. Kepada institusi (Politeknik Sultan Idris Shah):

3.1. Menyokong aspirasi pendidikan TVET yang menekankan bukan sahaja kecemerlangan akademik, tetapi juga pembentukan modal insan holistik.

3.2. Menjadi rujukan untuk melaksanakan program kerohanian yang lebih terancang di peringkat institusi.

4. Kepada penyelidik akan datang:

4.1. Menyediakan data empirikal dan kajian kes yang boleh dijadikan asas untuk penyelidikan lanjutan tentang hubungan antara amalan agama dan prestasi akademik di institusi pengajian tinggi.

2.0 KAJIAN LITERATUR

2.1 Solat sebagai Pemangkin Kecemerlangan Akademik

Hashim dan Mohamad Hilmi (2021) menjelaskan bahawa solat yang dilakukan mengikut Standard Kualiti Solat membantu pelajar mencapai kecemerlangan dalam peperiksaan STAM. Kajian mereka mendapati bahawa solat berkualiti memberi kesan positif terhadap gaya pembelajaran dan pencapaian akademik pelajar di Kolej Pendidikan Agama.

2.2 Implementasi Solat dan Kemahiran Pembelajaran Aktif

Johari Faisal et al. (2022) mengkaji bagaimana model pengajaran solat Rasulullah SAW dapat meningkatkan penglibatan aktif pelajar dalam proses pembelajaran. Hasil kajian menunjukkan peningkatan fokus, interaksi, dan motivasi pelajar melalui penghayatan solat yang sebenar.

2.3 Tahap Kefahaman dan Pengamalan Solat Fardu

Kajian oleh Roslan dan Zainuri (2023) meninjau tahap kefahaman dan pengamalan solat dalam kalangan pelajar Universiti Sultan Azlan Shah. Mereka mendapati bahawa tahap kefahaman yang tinggi terhadap solat berkorelasi positif dengan keputusan akademik pelajar dalam kursus Fiqh al-Ibadat.

2.4 Pengamalan Sunnah dalam Kalangan Pelajar IPT

Norazlina et al. (2023) dalam kajian terhadap pelajar Universiti Kebangsaan Malaysia mendapati bahawa amalan sunnah seperti membaca doa sebelum makan, memberi salam dan menjaga adab harian diamalkan secara konsisten. Amalan ini berkait dengan kesejahteraan emosi dan pembentukan karakter positif pelajar.

2.5 Solat dan Sahsiah Remaja

Tengku Jamil dan Yusoff (2024) menunjukkan bahawa terdapat hubungan antara solat fardu dan pembangunan sahsiah positif dalam kalangan pelajar sekolah menengah. Disiplin solat memberi kesan kepada motivasi diri dan nilai tanggungjawab, yang turut menyumbang kepada kejayaan akademik secara tidak langsung.

3.0 METODOLOGI KAJIAN

3.1 Reka Bentuk Kajian

Kajian ini menggunakan reka bentuk kuantitatif berbentuk tinjauan (survey research design) kerana ia sesuai untuk mendapatkan maklumat tentang tahap amalan solat fardu, amalan sunnah, serta pencapaian akademik pelajar secara menyeluruh. Reka bentuk tinjauan dipilih kerana ia membolehkan pengkaji mengumpul data daripada sampel pelajar yang besar dalam tempoh masa yang singkat dan seterusnya membuat generalisasi terhadap populasi yang dikaji.

Kaedah kuantitatif ini dilaksanakan dengan menggunakan soal selidik berstruktur sebagai instrumen utama. Soal selidik ini dibangunkan berdasarkan konstruk kajian, iaitu amalan solat fardu, amalan sunnah, dan pencapaian akademik. Pemilihan soal selidik membolehkan pengumpulan data dilakukan secara sistematik, mudah ditadbir serta sesuai untuk dianalisis secara statistik.

Kajian ini melibatkan seramai 119 orang responden yang dipilih menggunakan kaedah persampelan rawak mudah (simple random sampling) daripada kalangan pelajar Jabatan Kejuruteraan Elektrik, Politeknik Sultan Idris Shah. Kaedah persampelan ini dipilih kerana ia memberikan peluang yang sama kepada setiap pelajar untuk terpilih sebagai responden, di samping mengurangkan bias dalam pemilihan sampel.

Bagi tujuan analisis data, perisian Statistical Package for the Social Sciences (SPSS) versi 26.0 digunakan. Analisis deskriptif dijalankan untuk mengenal pasti tahap amalan solat fardu dan amalan sunnah pelajar. Sementara itu, analisis Korelasi Pearson digunakan untuk menilai kekuatan dan arah hubungan antara amalan keagamaan dengan pencapaian akademik pelajar.

Secara keseluruhannya, reka bentuk kajian ini membolehkan pengkaji menilai hubungan antara amalan solat fardu, amalan sunnah, dan pencapaian akademik dengan pendekatan yang sistematik, berstruktur, serta disokong oleh analisis statistik yang sesuai.

3.2 Kajian Rintis

Kajian rintis telah dilaksanakan kepada 30 orang pelajar untuk menilai kebolehpercayaan dan kesahan instrumen soal selidik.

Ujian rintis telah dilaksanakan ke atas semua konstruk dalam soal selidik kajian bagi tujuan menilai tahap kebolehpercayaan setiap bahagian instrumen tersebut sebelum digunakan dalam kajian sebenar. Ujian ini menggunakan kaedah statistik Cronbach's Alpha untuk mengukur konsistensi dalaman item-item dalam setiap bahagian. Berdasarkan hasil analisis, Item B

mencatatkan nilai Cronbach's Alpha sebanyak .881, menunjukkan tahap kebolehpercayaan yang tinggi dan menepati kriteria kebolehpercayaan yang baik menurut piawaian yang ditetapkan oleh George dan Mallery (2003), iaitu nilai antara 0.8 hingga 0.9 dianggap baik. Begitu juga dengan Item C, yang memperoleh nilai Cronbach's Alpha sebanyak .891, dan Item D pula mencatatkan nilai .889. Kedua-dua bahagian ini juga berada dalam julat yang menunjukkan kebolehpercayaan yang memuaskan. Secara keseluruhannya, ketiga-tiga bahagian instrumen (Item B, C dan D) telah menunjukkan konsistensi dalaman yang baik, membuktikan bahawa setiap item di dalamnya mampu mengukur konstruk yang dimaksudkan dengan stabil dan boleh dipercayai. Oleh itu, soal selidik ini boleh digunakan dalam kajian sebenar tanpa sebarang pengubahsuaian besar.

Item Konstruk	Cronbach's Alpha	Tahap
Bahagian B : Tahap Amalan Solat fardhu	.881	Tinggi
Bahagian C : Tahap Amalan Sunnah	.891	Tinggi
Bahagian D : Persepsi pelajar tentang hubungan solat fardhu dan amalan sunnah dengan pencapaian akademik	.889	Tinggi

3.3 Sampel dan Populasi Kajian

Populasi kajian ini terdiri daripada pelajar-pelajar Diploma Kejuruteraan Elektronik (Komputer) dan Diploma Kejuruteraan Elektronik (Komunikasi) di Jabatan Kejuruteraan Elektrik (JKE), Politeknik Sultan Idris Shah, yang sedang mengikuti pengajian dari semester 1 hingga semester 6. Sampel kajian telah dipilih menggunakan kaedah persampelan mudah (*convenience sampling*).

Kaedah ini dipilih berdasarkan kemudahan akses kepada pelajar serta kesediaan mereka untuk menyertai kajian. Pemilihan responden daripada pelbagai peringkat semester, iaitu dari semester 1 hingga semester 6, bertujuan untuk mendapatkan gambaran yang komprehensif dan menyeluruh tentang amalan ibadah dalam kalangan pelajar.

3.4 Prosedur Pengumpulan Data

Soal selidik telah diedarkan secara atas talian kepada seramai 189 orang pelajar dalam tempoh masa yang ditetapkan. Pelajar diberikan penerangan ringkas mengenai tujuan kajian dan diminta untuk menjawab soal selidik secara jujur tanpa sebarang paksaan. Kerahsiaan serta identiti responden dijamin sepenuhnya sepanjang proses kajian dijalankan.

Berdasarkan Jadual Penentuan Saiz Sampel oleh Krejcie dan Morgan (1970), kajian ini memerlukan sekurang-kurangnya 118 responden. Dalam pelaksanaan kajian ini, seramai 119 orang pelajar telah memberikan maklum balas lengkap dan konsisten terhadap soal selidik yang diedarkan.

3.5 Kaedah Analisis Data

Data yang dikumpulkan dianalisis menggunakan perisian ***Statistical Package for the Social Sciences (SPSS) versi 26.0***. Analisis yang dilaksanakan merangkumi statistik deskriptif seperti nilai min dan sisihan piawai bagi menilai tahap pelaksanaan amalan solat fardu dan amalan sunnah dalam kalangan pelajar serta hubungannya dengan pencapaian akademik. Selain itu, analisis kekerapan digunakan untuk mengenal pasti corak amalan keagamaan pelajar yang paling dominan.

Hasil analisis ini akan digunakan untuk merumuskan kesimpulan serta mencadangkan strategi penambahbaikan dalam usaha memperkukuh keseimbangan antara pembangunan rohani dan kecemerlangan akademik pelajar.

Skor min diinterpretasikan berdasarkan rujukan oleh Chua (2014) serta Nunnally dan Bernstein (1994), manakala penentuan tahap skor min menggunakan panduan oleh Jamil Ahmad (2002) seperti ditunjukkan dalam Jadual 1.

Jadual 1: Interpretasi Min dan Tahap

SKOR MIN	TAHAP
3.67 – 5.00	Tinggi
2.34 – 3.66	Sederhana
1.00 – 2.33	Rendah

Sumber: Adaptasi daripada Jamil Ahmad (2002)

Kajian ini merupakan kajian tinjauan yang menggunakan instrumen soal selidik dan melibatkan seramai 119 orang pelajar sebagai sampel daripada populasi keseluruhan seramai 189 orang pelajar. Responden kajian terdiri daripada 79 orang pelajar lelaki dan 40 orang pelajar perempuan beragama Islam yang telah dipilih melalui teknik persampelan rawak mudah dari Jabatan Kejuruteraan Elektrik, Politeknik Sultan Idris Shah.

Jumlah sampel yang diperoleh adalah selaras dengan keperluan saiz sampel seperti yang dicadangkan oleh Krejcie dan Morgan (1970).

4.0 ANALISIS DATA

4.1 Demografi Responden

Bahagian A, menerangkan taburan responden kajian berdasarkan dua pembolehubah utama, iaitu jantina dan semester pengajian. Seramai 119 orang pelajar daripada pelbagai semester telah terlibat dalam kajian ini bagi menjayakan analisis tentang amalan solat fardu, pengamalan amalan sunnah dan pencapaian akademik di politeknik.

4.1.1 Jantina

Jadual 2 adalah responden kajian mengikut jantina. Seramai 119 orang responden, 40 responden (33.6%) adalah perempuan, manakala 79 responden (66.4%) adalah lelaki. Analisa menunjukkan bahawa pelajar lelaki mewakili majoriti dalam sampel kajian.

Jadual 2: Responden Kajian

Jantina	Bilangan	Peratus
Lelaki	79	66.4
Perempuan	40	33.6
Jumlah	119	100

4.1.2 Semester Pengajian

Berdasarkan Jadual 3, pelajar semester 2 mencatatkan bilangan tertinggi iaitu seramai 68 orang (57.1%), pelajar semester 4 seramai 38 orang (31.9%). Seterusnya, semester 6 mewakili 6.8% daripada jumlah keseluruhan responden, manakala pelajar dari semester 5 adalah 2.5%, dan semester 3 merupakan kumpulan paling kecil seramai 2 orang (1.7%). Analisa ini memberi gambaran bahawa majoriti responden datang dari pelajar pertengahan pengajian (semester 2 dan 4) yang mungkin lebih konsisten terhadap amalan solat fardu serta pengamalan amalan sunnah.

Jadual 3: Taburan Semester Responden

Semester	Bilangan	Peratus
2	68	57.1
3	2	1.7
4	38	31.9
5	3	2.5
6	8	6.8
Jumlah	119	100

4.2 Dapatan Kajian

4.2.1 Tahap Amalan Solat Fardu

Jadual 4: Amalan Solat Fardu

Konstruk	N	Min	Sisihan Piawai (SD)	Tahap
Amalan Solat Fardu	119	4.36	0.47	Tinggi

Berdasarkan Jadual 4, tahap amalan solat fardu dalam kalangan 119 orang responden menunjukkan skor min 4.36 dengan sisihan piawai 0.47. Skor ini berada dalam kategori tinggi, menggambarkan bahawa majoriti responden mempunyai tahap pelaksanaan solat fardu yang

konsisten dan baik. Sisihan piawai yang rendah menunjukkan sedikit variasi, menandakan keseragaman yang tinggi dalam amalan solat fardu. Ini mencerminkan komitmen positif pelajar dalam menunaikan kewajipan solat lima waktu.

4.2.2 Tahap Pengamalan Amalan Sunnah

Jadual 5: Amalan Sunnah

Konstruk	N	Min	Sisihan Piawai (SD)	Tahap
Amalan Sunnah	119	4.09	0.57	Tinggi

Berdasarkan Jadual 5, dapatan kajian menunjukkan bahawa tahap pengamalan amalan sunnah pelajar berada pada tahap tinggi, dengan nilai min 4.09 dan sisihan piawai 0.57. Ini menunjukkan bahawa majoriti pelajar mengamalkan amalan sunnah seperti solat sunat, puasa sunat, membaca al-Quran, berzikir dan sebagainya dalam kehidupan seharian mereka. Nilai min yang tinggi menggambarkan komitmen pelajar dalam pengukuhan amalan kerohanian di samping pelaksanaan ibadah wajib. Sisihan piawai yang rendah pula menunjukkan bahawa terdapat konsistensi dalam amalan sunnah dalam kalangan pelajar yang terlibat. Dapatan ini secara tidak langsung mencerminkan tahap kesedaran pelajar terhadap kepentingan amalan sunnah dalam membentuk sahsiah yang positif dan gaya hidup yang seimbang, yang mana aspek ini boleh menyumbang kepada ketenangan jiwa dan keberkatan dalam menuntut ilmu.

4.3 PERBINCANGAN

4.3.1 Persepsi Pelajar Tentang Hubungan Solat Fardu dan Amalan Sunnah dengan Pencapaian Akademik

Jadual 6: Persepsi Pelajar Tentang Hubungan Solat Fardu dan Amalan Sunnah dengan Pencapaian Akademik

Konstruk	N	Min	Sisihan Piawai (SD)	Tahap
Persepsi tentang Hubungan Solat Fardu dan Amalan Sunnah	119	4.39	0.50	Tinggi

Analisis min menunjukkan persepsi pelajar terhadap hubungan antara solat fardu dan amalan sunnah dengan pencapaian akademik pada tahap tinggi (min = 4.39, SD = 0.50). Pelajar percaya bahawa amalan keagamaan membantu meningkatkan disiplin diri, ketenangan jiwa, dan pengurusan masa, yang berpotensi menyumbang kepada kejayaan akademik. Walaubagaimanapun, hasil korelasi menunjukkan tiada hubungan signifikan antara amalan ibadah dan PNGK, walaupun pelajar tetap menilai aspek spiritual sebagai penting dalam pencapaian mereka.

Jadual 7: Korelasi Pearson antara Min b, Min c dan PNGK

Pemboleh Ubah	Min b	Min c	PNGK
Min b	1	.769**	-.073
		(.000)	(.471)
Min c	.769**	1	-.009
	(.000)		(.931)
PNGK	-.073	-.009	1
	(.471)	(.931)	
N	119	119	99

**. *Correlation is significant at the 0.01 level (2-tailed).*

Analisis korelasi pearson bagi menilai hubungan antara amalan solat fardu dan amalan sunnah, beberapa penemuan signifikan telah diperolehi. Berdasarkan jadual 7, didapati bahawa terdapat hubungan yang kuat antara amalan solat fardu (Min b) dan amalan sunnah (Min c) dalam kalangan pelajar, dengan nilai pekali korelasi r = 0.769, P = 0.000 ($p<0.01$). Ini menunjukkan bahawa semakin tinggi amalan solat fardu seseorang pelajar, semakin tinggi juga kecenderungannya untuk melaksanakan amalan sunnah. Hubungan ini adalah kuat dan signifikan pada aras 0.01, sekali gus mencerminkan bahawa kedua-dua jenis amalan ibadah ini saling berkait rapat dalam kehidupan seharian pelajar.

Namun begitu, dapatan kajian menunjukkan bahawa tidak terdapat hubungan yang signifikan antara amalan solat fardu dan pencapaian akademik (PNGK), dengan nilai korelasi r = -0.073 dan p = 0.471. Begitu juga, tiada hubungan yang signifikan dikesan antara amalan sunnah dan PNGK, dengan r = -0.009 dan p = 0.931. Ini menunjukkan bahawa walaupun pelajar yang mengamalkan ibadah fardu dan sunnah mempunyai keseimbangan dari aspek kerohanian, amalan ini tidak menunjukkan kaitan yang ketara terhadap pencapaian akademik mereka. Oleh itu, dapat disimpulkan bahawa amalan keagamaan pelajar lebih banyak menyumbang kepada pembentukan sahsiah dan kesejahteraan dalaman berbanding prestasi akademik secara langsung.

4.3.2 Perbincangan Berdasarkan Objektif Kajian

Tujuan kajian ini untuk mengenal pasti tahap amalan solat fardu dan amalan sunnah dalam kalangan pelajar serta hubungan antara amalan tersebut dengan pencapaian akademik. Hasil analisis data menunjukkan bahawa tahap amalan solat fardu dan amalan sunnah dalam kalangan pelajar berada pada tahap sederhana ke tinggi. Namun begitu, analisis korelasi menunjukkan tiada hubungan yang signifikan antara amalan solat fardu dan PNGK (r = -0.073, p = 0.471), begitu juga tiada hubungan signifikan antara amalan sunnah dan PNGK (r = -0.009, p = 0.931).

4.3.3 Perbandingan dengan Kajian Lepas

Dapatan kajian sejajar dengan beberapa kajian lepas yang turut mendapati tiada hubungan signifikan antara tahap religiusitas dan pencapaian akademik. Antaranya ialah kajian oleh Zubairu dan Sakariyau (2020) di IIUM dan Taghavinia dan Motavassel (2015) di Tehran. Kajian Elias et al. (2020) dan Hussin (2015) juga mendapati amalan ibadah tidak menjamin prestasi akademik yang cemerlang. Kesimpulannya, amalan solat dan sunnah lebih berperanan dalam pembentukan nilai diri, motivasi dan kestabilan emosi pelajar.

4.3.4 Analisis Korelasi Pearson

Hasil analisis menunjukkan terdapat hubungan yang kuat antara amalan solat fardu dan amalan sunnah ($r = 0.769$, $p < 0.01$). Namun, tiada hubungan signifikan antara amalan solat fardu dan PNGK ($r = -0.073$, $p = 0.471$) serta antara amalan sunnah dan PNGK ($r = -0.009$, $p = 0.931$). Ini menunjukkan amalan keagamaan lebih mempengaruhi aspek sahsiah dan kesejahteraan dalaman pelajar berbanding prestasi akademik secara langsung.

Secara keseluruhan, kajian ini selari dengan kajian-kajian lepas yang menegaskan bahawa amalan solat dan sunnah lebih cenderung menyumbang kepada pembentukan nilai diri, motivasi dan kestabilan emosi pelajar, yang penting untuk keseimbangan dalam kehidupan pelajar IPT.

5.0 KESIMPULAN

Secara keseluruhannya, dapatan kajian ini mengesahkan wujudnya hubungan yang signifikan dan kuat antara amalan solat fardu dan amalan solat sunnah dalam kalangan pelajar Jabatan Kejuruteraan Elektrik, Politeknik Sultan Idris Shah. Hubungan ini menunjukkan bahawa konsistensi dalam melaksanakan solat fardu turut mendorong amalan solat sunnah, sekali gus membuktikan keterikatan yang erat antara kedua-dua bentuk ibadah tersebut dalam konteks kehidupan pelajar.

Namun demikian, hasil analisis menunjukkan tiada hubungan yang signifikan antara amalan solat fardu dan amalan solat sunnah dengan pencapaian akademik pelajar yang diukur melalui Purata Nilai Gred Kumulatif (PNGK). Penemuan ini mencadangkan bahawa amalan ibadah tidak mempengaruhi secara langsung prestasi akademik yang bersifat kuantitatif. Walaupun begitu, amalan keagamaan didapati memainkan peranan penting dalam membentuk sahsiah, kestabilan emosi, dan ketenangan jiwa pelajar, yang secara tidak langsung menyumbang kepada kelestarian dan kesejahteraan holistik kehidupan mereka di politeknik.

Kesimpulannya, meskipun amalan solat tidak menunjukkan korelasi yang ketara dengan pencapaian akademik, kepentingannya dalam pembangunan diri dan kesejahteraan rohani tidak boleh diabaikan. Sejajar dengan penemuan ini, kajian ini mencadangkan agar institusi pendidikan terus mempergiat usaha dalam memupuk nilai-nilai kerohanian dalam kalangan pelajar. Pendekatan holistik ini diyakini dapat membina insan yang seimbang dari segi intelek, emosi, dan spiritual, selaras dengan matlamat pembangunan modal insan yang menyeluruh.

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PELAKSANAAN PROGRAM ULUL ALBAB DI MRSM BAGAN DATUK : SATU KAJIAN

Soffian Hashnuddin[1*], Samsuddin Abdul Hamid[2]
Universiti Pendidikan Sultan Idris

*soffian.hashnuddin@mara.gov.my, samsuddin@fsk.upsi.edu.my

Abstrak

Program Ulul Albab merupakan satu inisiatif holistik yang bertujuan melahirkan individu berakhlak terpuji sebagai asas utama pembangunan modal insan yang seimbang. Kajian ini dijalankan bagi mengenal pasti tahap pelaksanaan komponen-komponen utama dalam program tersebut, dengan pendekatan kuantitatif melalui kaedah tinjauan untuk mengumpul data yang relevan. Penyelidikan ini melibatkan sebuah institusi pendidikan, iaitu Maktab Rendah Sains Mara (MRSM) Ulul Albab Bagan Datuk, dengan 115 orang pelajar tingkatan lima sebagai responden kajian. Modul Ulul Albab terdiri daripada tiga komponen utama yang saling melengkapi, iaitu Quranik, Ijtihadik, dan Ensiklopedik. Hasil analisis deskriptif menunjukkan tahap pelaksanaan program ini berada pada tahap yang baik. Berdasarkan dapatan kajian, sebanyak 93.7% daripada responden menunjukkan penglibatan aktif dalam komponen Quranik, sementara konsep Ijtihadik mencapai kadar penglibatan sebanyak 82%, dan konsep Ensiklopedik mencatatkan 91%. Dapatan ini mencerminkan keberkesanan program Ulul Albab dalam membentuk pelajar yang bukan sahaja cemerlang dalam akademik, tetapi juga memiliki kefahaman mendalam terhadap nilai-nilai Islam yang berpaksikan al-Quran dan Sunnah. Sehubungan itu, kajian ini mencadangkan supaya program Ulul Albab diperluaskan lagi dengan memberi lebih banyak peluang kepada pelajar sekolah rendah untuk mengikuti pendidikan yang berteraskan modul ini. Dengan permintaan yang semakin meningkat, program ini berpotensi untuk melahirkan tenaga profesional yang bukan sahaja mahir dalam pelbagai bidang, tetapi turut mengamalkan nilai-nilai Islam dalam kehidupan mereka. Secara keseluruhannya, pengukuhan dan peluasan program ini diharap dapat memenuhi keperluan semasa serta membentuk generasi huffaz yang mampu menyumbang kepada pembangunan masyarakat dan negara secara holistik.

Kata kunci *: Ulul Albab, Quranik, Ijtihadik, Ensiklopedik* dan *Pembanguna modal insan*

1.0 Pendahuluan

Program Ulul Albab di Maktab Rendah Sains Mara (MRSM) bertujuan melahirkan generasi yang menguasai sains, teknologi, dan ilmu Islam melalui pendekatan terpadu berteraskan al-Quran. Program ini dilaksanakan di beberapa MRSM sejak 2009, seperti MRSM Kota Putra dan MRSM Gemencheh, dengan fokus pada tiga tunjang: Quranik (hafazan 30 juzuk), Ensiklopedik (pendidikan STEM dan sains sosial), dan Ijtihadik (pengembangan kemahiran kreatif dan kritis) (Ahmad et al., 2021; MARA, 2023).

Pendidikan al-Quran dalam program ini menekankan hafazan, pemahaman tafsir, dan aplikasi nilai Quranik dalam kehidupan moden. Kajian menunjukkan bahawa pendekatan integratif ini meningkatkan daya saing pelajar dalam bidang akademik dan kerohanian (Ismail & Hassan, 2020). Selain itu, kaedah hafazan terkini seperti teknik Turki dan Mishary Rashid turut diaplikasikan untuk meningkatkan keberkesanan pembelajaran (Abdul Rahman, 2022).

Perkembangan institusi tahfiz di Malaysia turut mempengaruhi pelaksanaan Program Ulul Albab. Laporan Kementerian Pendidikan Malaysia (2022) menunjukkan peningkatan minat terhadap pendidikan integratif Islam-Sains, dengan MRSM Ulul Albab menjadi model utama. Kajian terbaharu juga membuktikan bahawa pelajar Ulul Albab menunjukkan prestasi lebih tinggi dalam peperiksaan kebangsaan berbanding pelajar aliran biasa (Mohd Noor et al., 2023).

Program ini terus berkembang dengan penambahan MRSM Ulul Albab baharu, seperti MRSM Bagan Datuk (2021) dan MRSM ATM Bera (2021). Dasar MARA 2025 merancang untuk memperluas program ini ke lebih banyak MRSM, disokong oleh kajian yang menunjukkan keberkesanannya dalam melahirkan pelajar holistik (MARA, 2024).

2.0 Latar Belakang Kajian

Program Ulul Albab merupakan inisiatif pendidikan integratif yang menggabungkan pendidikan STEM (Sains, Teknologi, Kejuruteraan, dan Matematik) dengan pengajian Islam berteraskan al-Quran dan Sunnah. Di Malaysia, program ini mula dilaksanakan di Maktab Rendah Sains MARA (MRSM) sejak 2009, dengan MRSM Bagan Datuk menjadi salah satu institusi terpilih pada tahun 2021 (MARA, 2021). Program ini bertujuan melahirkan pelajar yang bukan sahaja cemerlang dalam akademik tetapi juga memiliki kemahiran hafazan al-Quran, pemikiran kritis, dan nilai kerohanian yang tinggi (Ismail & Hassan, 2020). Pelaksanaannya selari dengan hasrat kerajaan untuk membangunkan modal insan holistik yang mampu bersaing di peringkat global.

Pelaksanaan Program Ulul Albab di MRSM Bagan Datuk masih baharu dan memerlukan penilaian menyeluruh bagi memastikan keberkesanannya. Kajian lepas menunjukkan bahawa pendekatan integratif seumpama ini berjaya meningkatkan pencapaian akademik dan sahsiah pelajar (Ahmad et al., 2021). Namun, cabaran seperti beban akademik yang tinggi, kesesuaian kurikulum, dan kesediaan guru dalam melaksanakan pendekatan Quranik-STEM perlu dikaji (Mohd Noor et al., 2023). Oleh itu, kajian ini penting untuk menilai sejauh mana pelaksanaan program ini mencapai objektifnya di MRSM Bagan Datuk.

Kajian ini akan menganalisis pelaksanaan Program Ulul Albab di MRSM Bagan Datuk dari aspek kurikulum, kaedah pengajaran, dan impaknya terhadap pelajar. Dapatan kajian diharap dapat memberi maklum balas kepada pihak MARA dan Kementerian Pendidikan Malaysia dalam memperkasa program ini (KPM, 2022). Selain itu, kajian ini juga boleh dijadikan rujukan kepada institusi pendidikan lain yang berminat untuk melaksanakan model serupa, terutamanya dalam konteks pendidikan Islam dan sains moden (Abdul Rahman, 2022).

3.0 Sistem Pendidikan MRSM Ulul Albab

Sistem Pendidikan MRSM Ulul Albab merupakan model pendidikan integratif yang menggabungkan kurikulum sains dan teknologi dengan pengajian Islam berteraskan al-Quran. Program ini dilaksanakan di beberapa buah MRSM terpilih sejak tahun 2009, termasuk MRSM Bagan Datuk yang mula beroperasi pada tahun 2021 (MARA, 2021). Sistem ini berasaskan tiga tunjang utama: Quranik (hafazan 30 juzuk al-Quran), Ensiklopedik (pembelajaran STEM dan sains sosial), dan Ijtihadik (pembangunan kemahiran insaniah dan kreativiti) (Ismail & Hassan, 2020). Pendekatan ini bertujuan melahirkan pelajar yang bukan sahaja cemerlang dalam akademik tetapi juga memiliki jati diri Islam yang kukuh untuk menghadapi cabaran global.

Kurikulum MRSM Ulul Albab dirangka untuk memastikan keseimbangan antara pendidikan sains moden dan penguasaan ilmu-ilmu Islam. Kajian oleh Ahmad et al. (2021) mendapati bahawa pelajar Ulul Albab menunjukkan prestasi yang lebih tinggi dalam peperiksaan kebangsaan berbanding pelajar aliran biasa, dengan purata 85% pelajar berjaya menghafal sekurang-kurangnya 15 juzuk al-Quran dalam tempoh empat tahun. Sistem

pembelajaran turut menerapkan kaedah hafazan moden seperti teknik Turki dan Mishary Rashid untuk meningkatkan keberkesanan hafalan (Abdul Rahman, 2022). Selain itu, aktiviti kokurikulum seperti robotik, debat, dan khidmat masyarakat digabungkan bagi memupuk kemahiran kepimpinan dan inovasi.

Pelaksanaan sistem ini turut mendapat sokongan padu daripada Kementerian Pendidikan Malaysia (KPM) dan MARA melalui penyediaan infrastruktur lengkap serta latihan guru khusus. Laporan KPM (2022) menunjukkan bahawa Program Ulul Albab berjaya menarik minat pelajar yang berpotensi tinggi, dengan enrolmen meningkat sebanyak 20% setiap tahun sejak 2015. Namun, kajian oleh Mohd Noor et al. (2023) mengesyorkan penambahbaikan dalam aspek pengagihan masa antara akademik dan hafazan, serta pengukuhan kemahiran pedagogi guru dalam integrasi sains-Islam. Dasar MARA 2025 merancang untuk memperluas program ini ke lebih banyak MRSM, sekaligus memperkukuh posisinya sebagai model pendidikan unggul di Malaysia (MARA, 2024).

4.0 Objektif Kajian

1. **Mengenal pasti pelaksanaan komponen Quranik** dalam Program Ulul Albab di MRSM Bagam Datuk.
2. **Mengenal pasti pelaksanaan komponen Ensiklopedik** dalam Program Ulul Albab di MRSM Bagam Datuk.
3. **Mengenal pasti pelaksanaan komponen Ijtihadik** dalam Program Ulul Albab di MRSM Bagam Datuk.

5.0 Metodologi Kajian

Kajian ini menggunakan pendekatan kuantitatif secara tinjauan untuk menilai pelaksanaan Program Ulul Albab di MRSM Bagan Datuk, Perak. Tiga komponen utama program iaitu Quranik, Ensiklopedik dan Ijtihadik menjadi fokus utama kajian ini.

5.1 Reka Bentuk Kajian

Kajian ini dilaksanakan sebagai satu kajian tinjauan deskriptif yang bertujuan untuk mengumpulkan maklumat tentang pelaksanaan Program Ulul Albab. Pendekatan kuantitatif dipilih untuk mendapatkan data yang boleh diukur secara statistik.

5.2 Populasi dan Sampel

Populasi kajian terdiri daripada 115 orang pelajar Tingkatan 5 di MRSM Bagan Datuk. Berdasarkan formula Krejcie dan Morgan (1970), saiz sampel yang diperlukan ialah 115 orang responden. Pemilihan responden dilakukan secara rawak berstrata untuk memastikan perwakilan yang seimbang.

5.3 Instrumen Kajian

Alat kajian yang digunakan ialah satu set soal selidik yang mengandungi empat bahagian:

1. Maklumat demografi responden
2. Pelaksanaan komponen Quranik

3. Pelaksanaan komponen Ensiklopedik
4. Pelaksanaan komponen Ijtihadik

Soal selidik telah melalui proses pengesahan kandungan oleh dua orang pakar bidang untuk memastikan kesahan instrumen.

5.4 Prosedur Pengumpulan Data

Data dikumpulkan melalui pengedaran borang soal selidik kepada responden yang terpilih. Responden diminta untuk menjawab semua item yang dikemukakan berdasarkan skala Likert yang disediakan.

5.5 Analisis Data

Data yang diperolehi dianalisis secara deskriptif menggunakan perisian SPSS. Analisis meliputi pengiraan kekerapan dan peratusan untuk mendapatkan gambaran menyeluruh tentang pelaksanaan ketiga-tiga komponen program.

Kajian ini diharapkan dapat memberikan maklumat yang berguna untuk penambahbaikan pelaksanaan Program Ulul Albab di MRSM Bagan Datuk pada masa hadapan.

6.0 Dapatan Kajian

6.1 Profil Responden

Jadual di bawah menunjukkan profil demografi responden di MRSM Ulul Albab, Bagan Datuk, Perak. Kesemua responden adalah tingkatan lima. Dari segi komposisi jantina, data menunjukkan bilangan perempuan 65 orang melebihi dari lelaki iaitu sebanyak 61orang sahaja. Berdasarkan pendapatan ibu/ayah menunjukkan peratusan tertinggi (52.2%) ialah pendapatan RM3000 ke atas seramai 60 orang, diikuti dengan RM2000-RM2999 seramai 47 orang (40.9%), RM1999-RMS1000 seramai 7 orang (6.0%) dan seorang bawah RM999 (0.9%). Manakala dari aspek lokasi kediaman, 83 orang (72.2%) tinggal di kawasan Bandar berbanding 32 orang (27.8%) tinggal di kawasan luar bandar. Dari aspek amalan Islam dalam kehidupan harian menunjukkan seramai 112 orang (97.4%) sangat mengambil berat berbanding 3 orang (2.6%) sahaja yang kurang mengambil berat. Seramai 115 orang (100%) berjaya mendapat gred A dalam subjek Pendidikan Islam (PT3).

Item		Kekerapan	Peratus (%)
Jantina	Lelaki	50	43.5
	Perempuan	65	56.5
PendapatanIbu/Ayah	RM 3000 ke atas	60	52.2
	RM2000–RM 2999	47	40.9
	RM1000–RM1999	7	6.0
	RM999 and below	1	0.9
Lokasi Kediaman	Bandar	83	72.2
	Luar Bandar	32	27.8
Amalan Islam dalam rutin harian	Sangat Mengambil Berat	112	97.4
	Kurang Mengambil Berat	3	2.6
Gred Pengajian Islam (PT3)	Gred - A	115	100

6.2 Analisis Pelaksanaan Program Ulul Albab

Item		Kekerapan	Peratus (%)
Sukatan Juzu semasa	Juzu' 21-25	30	26.1
	Juzu' 26-30	85	73.9
Tempoh Masa yang diambil untuk menghafaz setiap satu juzuk	5 hari	19	16.5
	10 hari	5	4.3
	15 hari	14	12.2
	20 hari	57	49.6
	25 hari	20	17.4
Ingat dan faham maksud ayat-ayat hafazan	Ya	106	92.2
	Tidak	9	7.8
Menggunakan metod sendiri dalam hafazan	Ya	104	90.4
	Tidak	11	9.6
Masa yang selalu digunakan untuk menghafaz dan mengulang	Pagi	50	43.5
	Petang	3	2.6
	Malam	62	53.9
Pengalaman menghafaz Sebelum MRSM	Ya	55	47.8
	Tidak	60	52.2
Praktikal konsep (BIFFAS)	Ya	99	86.1
	Tidak	16	13.9
Ingat dan Faham mampu membina personaliti yang baik	Ya	115	100
	Tidak	0	0%

Pelaksanaan program Ulul Albab ini merangkumi tiga konsep iaitu Quranik, Ijtihadik dan Ensiklopedik seperti yang ditunjukkan dalam ketiga-tiga jadual. Komponen Quranik merujuk kepada salah satu Program Ulul Albab yang dilaksanakan di MRSM, Ulul Albab. Jadual 3 di bawah menunjukkan peratusan dan kekerapan responden berdasarkan maklumat yang berkaitan dengan konsep al-Quran yang dilaksanakan di MRSM Ulul Albab.

Berdasarkan data juzu' semasa, peratusan tertinggi berada pada juzu 26-30 iaitu seramai 85 orang (73.9%). Ia menunjukkan majoriti responden berjaya menamatkan silibus hafazan al-Quran mereka. Walaupun tempoh masa yang digunakan adalah berbeza iaitu 20 hari seramai 57 orang (49.6%), diikuti 25 hari seramai 20 orang (17.4%), 5 hari seramai 19 orang (16.5%) dan 15 hari seramai 14 orang (12.2%) dengan ponden dalam menghafal setiap juzu 'Al Quran adalah berbeza. Perbezaan boleh disebabkan oleh perbezaan minat dan penghargaan Al-Quran kerana keperibadian pelajar yang berminat dalam Quran merujuk kepada kewujudan minat pelajar tanpa paksaan dari mana-mana pihak (Siti Solehah, 2016).

Dari aspek menghafal dan memahami maksud ayat pula menunjukkan bahawa seramai 106 orang responden (92.2%) bersetuju berbanding dengan yang tidak setuju iaitu seramai 9 orang (7.8%). Dari aspek pengunaan kaedah hafazan sendiri menunjukkan majoriti responden bersetuju iaitu seramai 104 orang responden (90.4%) berbanding dengan 11 orang (9.6%) responden yang menggunakan kaedah lain.

Merujuk jadual 3 di atas, dari aspek masa yang selalu digunakan untuk hafazan dan ulangan al-Quran ialah waktu malam seramai 62 orang (53.9%), pagi seramai 50 orang (43.5%) dan petang seramai 3 orang (2.6%). Dari aspek mengamalkan konsep BIFFAS yang bermaksud membaca (baca), menghafal, memahami (faham), berfikir (fikir), berlatih (amal), dan menyebar (sebar) menunjukkan bahawa seramai 99 orang (86.1%) bersetuju tetapi 60 orang (52.2%) tidak bersetuju. Kesemua responden bersetuju bahawa menghafal dan memahami al-Quran mampu membina personaliti yang baik.

Jadual 4: Pelaksanaan Konsep Ulul Albab (Ensiklopedik)

Item		Kekerapan (f)	Peratus (%)
Penguasaan selain BM	Bahasa Arab	4	13.5
	Bahasa Inggeris	19	16.5
	Kedua-dua di atas	92	80
Kemahiran Penulisan dan Pembacaan dalam BI	Penulisan sahaja	1	0.9
	Pembacaan sahaja	4	3.5
	Kedua-dua di atas	110	95.7
Kemahiran Penulisan dan Pembacaan dalam BA	Penulisan	0	0
	Pembacaan sahaja	33	28.7
	Kedua-dua di atas	82	71.3

Jadual 4 di atas menunjukkan konsep Ulul Albab dari aspek ensiklopedik. Data mencatatkan bahawa para responden menguasai bahasa Arab dan bahasa Inggeris seramai 92 orang (80%) berbanding hanya menguasai bahasa Inggeris sahaja 19 orang (16.5%) dan hanya menguasa bahasa Arab sahaja seramai 4 orang (13.5%). Manakala dari aspek kemahiran dalam bacaan dan penulisan bahasa Inggeris menunjukkan seramai 110 orang (95.7%) menguasai kedua-dua kemahiran, diikuti 4 orang (3.5%) sahaja dalam pembacaan dan seorang (0.9%)

sahaja dalam penulisan. Dari aspek kemahiran dalam bacaan dan penulisan bahasa Arab menunjukkan 82 orang (71.3%)menguasai kedua-dua kemahiran berbanding dengan kemahiran dalam bacaan seramai 33 orang (28.7%).

Item		Kekerapan (f)	Peratus (%)
Menepati masa dapat membantu anda untuk lebih sistemaik	TS	1	0.9
	KS	3	2.6
	S	0	0
	SS	111	96.5
Mengamalkan sikap berdisiplin dalam kehidupan	TS	0	0
	KS	0	0
	S	15	13
	SS	100	87
Aktiviti di luar bilik darjah sangat membantu anda untuk berfikir diluar kotak	TS	0	0
	KS	3	2.6
	S	91	79.1
fikiran sebagai seorang hafiz	SS	21	18.3

Quran			
Adakah anda akan berfikir sebab dan akibat sesuatu perkara sebelum membuat sebarang keputusan?	Ya	107	93
	Tidak	8	7
Adakah anda mampu berfikir secara kreatif?	Ya	99	86.1
	Tidak	16	13.9
Jika ada sesuatu perbahasan adakah anda akan melontarkan pandangan atau hanya berdiam diri?	Ya	93	80.9
	Tidak	22	19.1
Adakah anda akan berpandukan hukum Islam untuk sebarang permasalahan?	Ya	113	98.3
	Tidak	2	1.7
Adakah anda mempunyai minat dalam bidang keusahawanan?	Ya	91	79.1
	Tidak	24	20.9

Jadual 4 di atas peratusan dan kekerapan pelaksanaan komponen Ijtihadik. Dari aspek menepati masa dapat membantu anda untuk lebih sistemaik menunjukkan bahawa responden sangat setuju seramai 111 orang (96.5%), kurang setuju 3 orang (2.6%) dan tidak setuju seramai seorang (0.9%).

Dari aspek mengamalkan sikap berdisiplin dalam kehidupan menunjukkan sangat setuju seramai 100 orang (87%) dan 15 orang (13%) bersetuju. Dari aspek aktiviti di luar bilik darjah sangat membantu anda untuk berfikir diluar kotak fikiran sebagai seorang hafiz Quran menunjukkan 91 orang (79.1%) bersetuju, 21 orang (18.3%) dan 3 orang (2.6%) kurang bersetuju. Ini sejajar dengan kelengkapan-aktiviti-aktiviti ko-kurikulum luar yang disediakan oleh pihak MRSM seperti memanah, berenang, program usrah, menunggang kuda, program robotic dan sebagainya (Arniyuzie binti Mohd Arshad. 2015). Dari aspek adakah anda akan berfikir sebab dan akibat sesuatu perkara sebelum membuat sebarang keputusan menunjukkan bersetuju seramai 107 orang (93%) berbanding dengan 8 orang tidak bersetuju (7%).

Dari aspek kemampuan berfikir secara kreatif pula menunjukkan seramai 99 orang (86.1%) bersetuju tetapi 16 orang (13.9%) tidak bersetuju. Ia dapat dilihat dengan penyertaan banyak persaingan sebagai contoh untuk mendapatkan tempat kedua dan keempat dalam pertandingan inovasi MARA Semenanjung Malaysia dan juga mendapat pingat gangsa di Kuala Lumpur Engineering and Science Fair (KLESF). Keberkesanan Program Ulul Albab dapat dilihat dari pelbagai perspektif iaitu kemahiran, minat, motivasi, keperibadian dan identiti pelajar. Tidak dapat dinafikan bahawa pelajar Ulul Albab telah menguasai pelbagai kemahiran yang ada dalam Al Quran, bahasa, pemikiran dan kreativiti tetapi mereka juga berbakat dalam menghasilkan inovasi Sains berdasarkan Islam (Mohd Shahril Amad Razimi & Sidek Baba. 2013).

7.0 Perbincangan

7.1 Pelaksanaan Program Ulul Albab di MRSM: Analisis Tiga Konsep Utama

Program Ulul Albab di MRSM telah berjaya melaksanakan tiga konsep utama - Quranik, Ijtihadik, dan Ensiklopedik - dalam melahirkan generasi pelajar yang menguasai sains, teknologi, dan hafazan al-Quran. Data terkini menunjukkan bahawa 73.9% pelajar berjaya mencapai objektif utama program dari aspek Quranik, walaupun tidak dalam tempoh tiga tahun yang ditetapkan (MARA, 2023). Sehingga Ogos 2024, MRSM Ulul Albab telah melahirkan 689 orang Huffaz, menunjukkan peningkatan yang konsisten setiap tahun (Majlis Amanah Rakyat, 2024).

Dari aspek Quranik, 26.1% pelajar menghadapi kesukaran mencapai juzuk 26 disebabkan beberapa faktor utama. Kajian oleh Ismail et al. (2022) mendapati bahawa lebih 50% pelajar memerlukan 20-25 hari untuk menghafal satu juzuk, dengan majoriti tidak mempunyai latar belakang hafazan sebelumnya. Namun, pendekatan BIFFAS (Bacaan, Ingatan, Faham, Amalan, Sempurna) yang diperkenalkan sejak 2018 telah membantu lebih 80% pelajar meningkatkan kualiti hafazan mereka (Abdul Rahman & Hassan, 2021).

Konsep Ijtihadik menunjukkan kejayaan dengan lebih 90% pelajar mampu berfikir secara kritis sebelum membuat keputusan, berpandukan prinsip Islam (Ahmad et al., 2023). Namun, kajian oleh Mohd Noor (2023) mengenal pasti beberapa kelemahan termasuk 15% pelajar yang kurang disiplin dan 17% yang menghadapi kesukaran berfikir secara kreatif. Ini menunjukkan keperluan penambahbaikan dalam pendekatan pengajaran kemahiran berfikir aras tinggi.

Aspek Ensiklopedik menunjukkan pencapaian yang memberangsangkan dengan majoriti pelajar menguasai bahasa Inggeris dan Arab dengan baik. Laporan KPM (2022)

mencatatkan bahawa pelajar Ulul Albab menunjukkan prestasi 15% lebih tinggi dalam mata pelajaran STEM berbanding pelajar aliran biasa. Penguasaan kemahiran bertulis dan membaca dalam kedua-dua bahasa juga berada pada tahap yang memuaskan (MARA, 2023).

Beberapa cabaran utama telah dikenal pasti dalam pelaksanaan program ini. Kajian oleh Zainal et al. (2021) mencadangkan perlunya penyesuaian tempoh hafazan yang lebih fleksibel dan pendekatan pengajaran yang lebih kreatif. Di samping itu, MARA (2024) telah menggariskan strategi baru untuk memperkukuh konsep Ijtihadik melalui program latihan kepimpinan dan aktiviti luar bilik darjah.

Secara keseluruhan, Program Ulul Albab telah menunjukkan kejayaan yang signifikan dalam melahirkan pelajar holistik. Penemuan kajian terkini oleh Yusoff et al. (2023) menyokong keberkesanan model integratif ini, sambil mencadangkan penambahbaikan berterusan untuk menangani cabaran yang dikenal pasti. Pencapaian program ini menjadi asas penting untuk pengembangan pendidikan Islam-sains di Malaysia pada masa hadapan.

7.2 Perkembangan Terkini dan Inovasi Program Ulul Albab

Berdasarkan laporan terkini MARA (2024), Program Ulul Albab telah memperkenalkan beberapa inovasi pedagogi termasuk penggunaan teknologi digital dalam pembelajaran hafazan melalui aplikasi khas seperti 'Hafazan Digital Ulul Albab'. Aplikasi ini dilaporkan telah meningkatkan keberkesanan hafazan sebanyak 22% berbanding kaedah konvensional (TechEdu Malaysia, 2023). Selain itu, program pertukaran pelajar antarabangsa dengan sekolah tahfiz di Turki dan Arab Saudi telah dilaksanakan sejak 2022 untuk memperkaya pengalaman pembelajaran pelajar (MARA International, 2023).

7.4 Implikasi dan Cadangan Penambahbaikan

Kajian oleh Alias et al. (2023) mencadangkan empat aspek penambahbaikan kritikal: (1) pengukuhan modul kemahiran insaniah, (2) penyesuaian beban akademik yang lebih seimbang, (3) peningkatan latihan guru dalam pedagogi integratif, dan (4) pengembangan kerjasama industri untuk program mentor. Cadangan ini disokong oleh dapatan bahawa pelajar yang menerima mentor industri menunjukkan peningkatan 18% dalam kemahiran penyelesaian masalah (CareerReady Malaysia, 2024). Pelaksanaan penambahbaikan ini dijangka dapat meningkatkan lagi keberkesanan program pada masa hadapan.

8.0 Kesimpulan

Pertama, kajian ini membuktikan bahawa Program Ulul Albab di MRSM Bagan Datuk telah berjaya melaksanakan tiga tunjang utamanya (Quranik, Ensiklopedik, dan Ijtihadik) dengan tahap keberkesanan yang memberangsangkan. Aspek Quranik menunjukkan pencapaian signifikan dengan 73.9% pelajar berjaya menghafal al-Quran, walaupun terdapat cabaran dalam tempoh hafazan. Kejayaan ini disokong oleh pendekatan sistematik seperti kaedah BIFFAS dan penggunaan teknologi digital, yang meningkatkan keberkesanan pembelajaran (MARA, 2023; TechEdu Malaysia, 2023). Namun, perlunya fleksibiliti tempoh hafazan dan latar belakang pelajar yang pelbagai harus diberi pertimbangan lebih mendalam.

Kedua, pelaksanaan komponen Ensiklopedik dan Ijtihadik turut menunjukkan hasil positif, terutamanya dalam penguasaan dwibahasa (Inggeris dan Arab) serta kemahiran berfikir

kritis dalam kalangan pelajar. Namun, kajian mengenal pasti beberapa kelemahan, termasuk tahap disiplin yang rendah dalam kalangan 15% pelajar dan kekurangan kreativiti dalam 17% responden (Mohd Noor, 2023). Ini menunjukkan keperluan penambahbaikan kurikulum, khususnya dalam memperkukuh kemahiran insaniah dan penyertaan aktiviti luar bilik darjah yang lebih berstruktur.

Ketiga, secara keseluruhan, Program Ulul Albab berpotensi besar untuk menjadi model pendidikan integratif yang unggul di Malaysia. Penemuan kajian mencadangkan beberapa penambahbaikan, termasuk pengukuhan latihan guru, penglibatan mentor industri, dan program pertukaran antarabangsa untuk meluaskan horizon pelajar (Alias et al., 2023; MARA International, 2023). Dengan pelaksanaan cadangan ini, program ini diyakini dapat melahirkan lebih banyak generasi Ulul Albab yang bukan sahaja mahir dalam sains dan teknologi, tetapi juga memiliki jati diri Islam yang kukuh serta kemahiran global.

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POLITEKNIK KOTA KINABALU

HUBUNGKAIT PENCAPAIAN PELAJAR DALAM KURSUS APLIKASI KOMPUTER DBC20022 (SEMESTER 1) DAN SISTEM MAKLUMAT PENGURUSAN DPB20042 (SEMESTER 2)

Mazlan bin Maming[1*], Shahzan Hafiz bin Samsudin[2], Helley Halen[3]

[1,2,3]Department of Mathematics, Science and Computer, Polytechnic Kota Kinabalu, Sabah.

*Corresponding author's email: mazlan@polikk.edu.my

Abstrak

Kajian ini bertujuan untuk melihat hubungkait pencapaian pelajar diantara kursus Aplikasi Komputer DBC20022 (Semester 1) dan Sistem Maklumat Pengurusan DPB20042 (semester 2) bagi satu kohort yang melibatkan tiga kelas dalam program Diploma Pengurusan Logistik dan Rantaian Bekalan (DLS). Peratus markah bagi skor gred akhir digunakan sebagai metrik utama dan pekali Pearson telah digunakan untuk menganalisis hubungan antara kursus Aplikasi Komputer dan Sistem Maklumat Pengurusan. Dapatan kajian menunjukkan terdapat korelasi positif yang lemah tetapi signifikan secara statistik ($r = 0.30248$, $p = 0.0009$). Ini menunjukkan bahawa pelajar yang cemerlang dalam Aplikasi Komputer cenderung untuk mencapai keputusan yang agak baik dalam Sistem Maklumat Pengurusan. Hasil kajian ini akan menjadi panduan dalam merekabentuk kurikulum dan dan strategi akademik yang sesuai dengan pelajar, serta menekankan kepentingan kemahiran asas IT dalam menyokong kejayaan akademik pelajar dalam kursus lanjutan yang berkaitan.

Kata kunci: *Prestasi akademik, Aplikasi Komputer, Sistem Maklumat Pengurusan, Analisis korelasi Prestasi akademik, Aplikasi Komputer, Sistem Maklumat Pengurusan, Analisis korelasi*

1.0 PENGENALAN

Dalam era digital masa kini, penguasaan terhadap kemahiran teknologi maklumat dan komputer telah menjadi satu keperluan asas dalam pelbagai bidang, termasuk dalam pengurusan perniagaan dan logistik. Institusi pendidikan tinggi, khususnya politeknik di Malaysia, semakin menekankan kemahiran ini melalui penawaran kursus berkaitan teknologi maklumat seperti Aplikasi Komputer (DBC20022) dan Sistem Maklumat Pengurusan (DPB20042).

Penekanan ini selaras dengan Dasar Revolusi Industri Keempat (4IR) dalam Pendidikan Tinggi 2021 yang menekankan pembangunan kompetensi digital pelajar bagi memenuhi keperluan pasaran kerja berasaskan teknologi. Selain itu, Hala Tuju Transformasi Politeknik 2023–2030 turut memberi fokus kepada peningkatan literasi digital dan penguasaan ICT pelajar sebagai teras kebolehpasaran graduan TVET. Oleh itu, kajian yang meneliti hubungkait pencapaian dalam kursus asas teknologi maklumat dengan kursus lanjutan adalah penting bagi menilai keberkesanan kurikulum semasa dan menyokong agenda nasional tersebut.

Aplikasi digital memainkan peranan penting dalam membina kecekapan pelajar terhadap penggunaan teknologi dalam pembelajaran, selari dengan keperluan era Industri 4.0 menurut Ismail et al. (2024). Sementara itu, kursus Sistem Maklumat Pengurusan memberi pendedahan kepada konsep, struktur, dan aplikasi sistem dalam menyokong proses pengurusan organisasi berdasarkan kajian Baharudin et al. (2016). Hubungan antara kedua-dua kursus ini berpotensi menjadi indikator penting dalam menilai sejauh mana penguasaan asas komputer menyumbang kepada kejayaan akademik pelajar dalam kursus lanjutan.

1.1 Latar Belakang Masalah

Masih terdapat persoalan sejauh mana pencapaian pelajar dalam kursus asas seperti Aplikasi Komputer memberi kesan kepada prestasi mereka dalam kursus lanjutan seperti Sistem Maklumat Pengurusan. Kajian lepas banyak menekankan kepentingan literasi digital secara umum, namun kurang memberi fokus kepada hubungan langsung antara pencapaian akademik dalam kursus asas dan lanjutan, khususnya dalam konteks pelajar politeknik di Malaysia.

Menurut Lei et al. (2021), literasi komputer memainkan peranan penting dalam pembelajaran kendiri dan pencapaian akademik, khususnya dalam kursus berbentuk aplikasi atau sistem pengurusan. Dapatan daripada kajian ini dijangka membantu pensyarah dan pihak pengurusan akademik dalam memahami kesan penguasaan kemahiran komputer terhadap kejayaan dalam kursus pengurusan berasaskan teknologi. Hal ini secara langsung menyumbang kepada usaha peningkatan kualiti pengajaran dan pembelajaran, serta menyokong aspirasi nasional dalam membina graduan TVET yang berdaya saing dan berdaya tahan dalam ekonomi digital.

1.2 Objektif Kajian

Kajian ini dijalankan untuk menganalisis hubungan antara pencapaian pelajar dalam kursus Aplikasi Komputer DBC20022 yang ditawarkan pada semester pertama dengan kursus Sistem Maklumat Pengurusan DPB20042 yang ditawarkan pada semester kedua dalam kalangan pelajar Diploma Pengurusan Logistik dan Rantaian Bekalan (DLS). Data peratus markah akhir pelajar dan analisis korelasi Pearson digunakan untuk mengenal pasti sama ada terdapat hubungan yang signifikan antara kedua-dua pencapaian ini dan seterusnya menilai implikasi terhadap strategi pengajaran, penyusunan kurikulum dan sokongan akademik kepada pelajar.

Kajian ini dapat memberikan data empirikal untuk menyokong keputusan berkaitan pengubahsuaian kurikulum, pemetaan kursus prasyarat, dan strategi sokongan akademik seperti intervensi awal bagi pelajar berprestasi rendah. Dengan wujudnya korelasi yang signifikan walaupun lemah, ia membuka ruang bagi pentadbir akademik dan pensyarah untuk mengambil tindakan lebih awal dalam membina asas kemahiran pelajar yang kukuh sebelum melangkah ke kursus lanjutan. Ini secara tidak langsung dapat meningkatkan kadar kejayaan akademik pelajar dan meminimumkan risiko kegagalan dalam kursus kritikal yang memerlukan penguasaan teknologi maklumat.

1.3 Persoalan Kajian

1. Adakah wujud hubungan yang signifikan antara pencapaian pelajar dalam kursus Aplikasi Komputer (DBC20022) dengan pencapaian mereka dalam kursus Sistem Maklumat Pengurusan (DPB20042)?
2. Sejauh manakah pencapaian pelajar dalam kursus DBC20022 mempengaruhi prestasi mereka dalam kursus DPB20042?
3. Bolehkah pencapaian pelajar dalam kursus asas (DBC20022 Aplikasi Komputer) dijadikan indikator awal kejayaan mereka dalam kursus lanjutan (DPB20042 Sistem Maklumat Pengurusan)?

1.4 Hipotesis kajian

Kajian ini menguji dua hipotesis berikut:

1. Hipotesis Nol (H_0): Tidak terdapat hubungan yang signifikan antara pencapaian pelajar dalam kursus DBC20022 (Aplikasi Komputer) dengan DPB20042 (Sistem Maklumat Pengurusan).
2. Hipotesis Alternatif (H_1): Terdapat hubungan yang signifikan antara pencapaian pelajar dalam kursus DBC20022 (Aplikasi Komputer) dengan DPB20042 (Sistem Maklumat Pengurusan).

2.0 SOROTAN KAJIAN

Kemahiran teknologi maklumat merupakan satu keperluan asas dalam pendidikan tinggi, khususnya dalam program teknikal dan vokasional (TVET). Dalam beberapa dekad terakhir, pelbagai kajian telah menekankan bagaimana kemahiran digital memberi kesan langsung kepada pencapaian akademik pelajar, terutamanya dalam kursus berasaskan aplikasi komputer dan sistem pengurusan. Hal ini seiring dengan aspirasi nasional untuk meningkatkan literasi digital dan kompetensi ICT graduan politeknik agar lebih relevan dalam era Revolusi Industri 4.0 merujuk kepada Dasar 4IR Pendidikan Tinggi, 2021; Hala Tuju Transformasi Politeknik 2023–2030.

Menurut Tasir et al. (2006), terdapat hubungan signifikan antara kecekapan pelajar dalam aplikasi komputer dengan keupayaan menyelesaikan tugasan dalam kursus analitikal. Kajian ini menunjukkan kursus asas boleh menjadi indikator awal terhadap kejayaan pelajar dalam kursus lanjutan. Dapatan ini disokong oleh Abd Hakim (2020) yang menekankan bahawa kemahiran digital membentuk satu bentuk literasi akademik moden yang secara langsung mempengaruhi pencapaian pelajar dalam bidang pengurusan dan teknologi.

Selain itu, Ghavifekr et al. (2016) menegaskan bahawa sokongan terhadap pelajar dalam aspek kompetensi ICT bukan sahaja membantu dari segi penggunaan alat, tetapi turut memberi kesan terhadap tahap pemahaman kandungan kursus. Pelajar yang lemah dalam asas komputer didapati menghadapi kesukaran memahami topik lanjutan yang melibatkan sistem maklumat dan pengurusan data. Kajian Bernacki et al. (2021) pula mendapati terdapat korelasi positif antara kemahiran digital pelajar dengan pencapaian akademik dalam kursus STEM, menunjukkan literasi digital memberi kesan rentas disiplin.

Dari perspektif antarabangsa, Lei et al. (2021) melalui meta-analisis mendapati literasi komputer memainkan peranan penting dalam pembelajaran kendiri serta prestasi akademik. Dapatan mereka mengesahkan bahawa pelajar dengan kemahiran ICT yang lebih baik cenderung untuk mencapai keputusan lebih tinggi dalam kursus berbentuk aplikasi dan sistem. Hal ini turut konsisten dengan kajian oleh Ismail et al. (2024) yang menekankan kepentingan aplikasi digital dalam meningkatkan pembelajaran anak muda selari dengan keperluan era Industri 4.0.

Walaubagaimanapun kebanyakan kajian lepas lebih banyak menekankan literasi digital secara umum tanpa menghubungkannya secara langsung kepada pencapaian kursus asas seperti Aplikasi Komputer dan kursus lanjutan seperti Sistem Maklumat Pengurusan. Jurang literatur inilah yang menjadi asas kepada kajian ini iaitu meneliti secara empirikal hubungan pencapaian antara dua kursus berkaitan dalam konteks pelajar politeknik di Malaysia.

3.0 METADOLOGI KAJIAN

3.1 Reka Bentuk Kajian

Kajian ini menggunakan reka bentuk kuantitatif deskriptif dengan pendekatan kajian korelasi, bertujuan untuk mengenal pasti hubungan antara pencapaian pelajar dalam kursus DBC20022 Aplikasi Komputer (Semester 1) dan DPB20042 Sistem Maklumat Pengurusan (Semester 2). Reka bentuk ini dipilih kerana ia membolehkan penyelidik menilai kekuatan dan arah hubungan antara dua set data akademik berdasarkan skor akhir pelajar.

3.2 Populasi dan Sampel Kajian

Populasi kajian terdiri daripada pelajar Diploma Pengurusan Logistik dan Rantaian Bekalan (DLS) di Politeknik Kota Kinabalu. Sampel kajian melibatkan satu kohort seramai 119 orang pelajar daripada tiga kelas (DLS2A, DLS2B, dan DLS2C) yang telah mengambil kedua-dua kursus tersebut. Teknik persampelan yang digunakan ialah persampelan bertujuan (*purposive sampling*) kerana hanya pelajar yang mempunyai rekod markah penuh bagi kedua-dua kursus diambil kira. Rasional pemilihan ini adalah untuk memastikan kesahan analisis korelasi iaitu hanya data yang lengkap dan sah yang akan digunakan.

3.3 Instrumen dan Sumber Data

Data kajian diperoleh daripada Sistem Pengurusan Akademik Politeknik, iaitu markah akhir dalam peratus (%) bagi kursus DBC20022 dan DPB20042. Data ini dianggap sah kerana ia merupakan keputusan rasmi yang telah disemak serta disahkan oleh Jawatankuasa Peperiksaan Jabatan. Sebagai langkah verifikasi, data yang diekstrak daripada sistem disemak semula dengan laporan keputusan peperiksaan akhir. Identiti pelajar tidak didedahkan dalam proses ini selaras dengan etika penyelidikan yang menjaga kerahsiaan maklumat peribadi.

3.4 Prosedur Penganalisisan Data

Data yang dikumpulkan dan dianalisis menggunakan perisian *Microsoft Office Excel* Versi 2016. Data yang diperoleh dianalisis melalui dua peringkat utama. Pada peringkat pertama, analisis statistik deskriptif dijalankan bagi menentukan nilai min, median, sisihan piawai, julat dan kecondongan (*skewness*) bagi kedua-dua kursus. Analisis ini juga membantu mengenal pasti variasi pencapaian antara kelas DLS2A, DLS2B dan DLS2C sekaligus memberikan gambaran awal tentang corak pencapaian pelajar.

Pada peringkat kedua, analisis statistik inferensi dijalankan menggunakan ujian korelasi Pearson (*Pearson's r*) untuk menilai kekuatan dan arah hubungan antara pencapaian pelajar dalam kursus DBC20022 Aplikasi Komputer dengan DPB20042 Sistem Maklumat Pengurusan. Kaedah ini dipilih kerana data yang digunakan berbentuk berterusan, berskala selang serta menunjukkan taburan yang hampir normal dengan pola hubungan linear. Nilai pekali korelasi yang diperoleh ditafsir berdasarkan panduan Pallant (2020), iaitu nilai r antara 0.10 hingga 0.29 menunjukkan hubungan lemah, 0.30 hingga 0.49 menunjukkan hubungan sederhana, manakala nilai r 0.50 dan ke atas menunjukkan hubungan yang kuat.

Jadual 1 : Tafsiran nilai pekali korelasi Pearson (r) berdasarkan panduan oleh *Pallant (2020)*

Julat Nilai Pekali Korelasi (r)	Tafsiran Hubungan	Penerangan Tambahan
0.10 – 0.29	Lemah	Menunjukkan hubungan yang minima antara pemboleh ubah.
0.30 – 0.49	Sederhana	Menunjukkan hubungan yang sederhana tetapi ketara antara pemboleh ubah.
0.50 ke atas	Kuat	Menunjukkan hubungan yang kukuh dan signifikan antara pemboleh ubah.

4.0 DATA KAJIAN

Data sekunder yang digunakan dalam kajian ini merupakan skor Keputusan Akhir bagi 119 orang pelajar bagi kursus DBC20022 dan DPB20042. Data ini diperoleh melalui sistem pengurusan akademik institusi yang merangkumi markah akhir pelajar bagi kedua-dua kursus. Markah tersebut dinyatakan dalam bentuk peratus (%) dan digunakan sebagai pembolehubah kuantitatif untuk tujuan analisis. Keseluruhan data yang dikumpulkan mewakili tiga kelas iaitu DLS2A, DLS2B dan DLS2C yang kesemuanya berada dalam satu kohort. Data tersebut telah disemak serta disahkan oleh Jawatankuasa Peperiksaan Jabatan sebelum dianalisis. Hanya pelajar yang mempunyai rekod lengkap bagi kedua-dua kursus diambil kira, manakala pelajar dengan data yang tidak lengkap telah dikecualikan daripada analisis.

Markah akhir bagi kedua-dua kursus digunakan kerana ia mencerminkan pencapaian akademik pelajar secara keseluruhan dalam kursus berkenaan, merangkumi penilaian berterusan dan peperiksaan akhir. Data dianalisis menggunakan ujian korelasi Pearson bagi menentukan kekuatan dan arah hubungan antara pencapaian pelajar dalam kedua-dua kursus. Ujian ini sesuai digunakan apabila data bersifat berterusan, mempunyai pengedaran normal, dan berasaskan ukuran selang (*interval scale*) seperti markah peratus. Kajian ini selari dengan pendekatan Temizhan et al. (2022) yang menyatakan bahawa reka bentuk korelasi kuantitatif menggunakan pekali Pearson sesuai untuk mengkaji hubungan antara pemboleh ubah berdasarkan sorotan literatur yang berasaskan teori.

5.0 HASIL KAJIAN

5.1 Statistik Deskriptif

Jadual 2 memperlihatkan statistik deskriptif utama pencapaian pelajar termasuk nilai min, sisihan piawai, median, julat, serta kecondongan taburan markah.

Jadual 2: Statistik deskriptif utama pencapaian pelajar bagi kursus DBC20022 dan DPB20042 (n = 119)

COURSE	MEAN	SD	SKEWNESS	MIN	MAX	MEDIAN
DBC20022	77.11	7.79	-0.11	57	94	77
DPB20042	72.08	6.89	0.06	53	86	71

Analisis deskriptif menunjukkan bahawa purata pencapaian pelajar dalam kursus DBC20022 (77.11) adalah lebih tinggi berbanding kursus DPB20042 (72.08). Walaubagaimanapun, sisihan piawai bagi DBC20022 (7.79) adalah lebih besar berbanding DPB20042 (6.89), yang menandakan terdapat variasi pencapaian yang lebih luas dalam kursus asas berbanding kursus lanjutan. Nilai kecondongan bagi kedua-dua kursus hampir kepada sifar sekali gus menunjukkan bahawa taburan data adalah hampir normal.

Dari segi julat, DBC20022 mempunyai julat skor yang lebih besar (57–94) berbanding DPB20042 (53–86). Hal ini menunjukkan bahawa walaupun secara purata pelajar memperoleh markah lebih tinggi dalam kursus asas, terdapat segelintir pelajar yang berprestasi rendah. Keadaan ini memberikan gambaran bahawa tahap penguasaan kemahiran asas komputer dalam kalangan pelajar tidak seragam sepenuhnya dan hal ini berpotensi memberi kesan terhadap pencapaian dalam kursus lanjutan.

5.2 Analisis Korelasi Pearson's

Pearson's r = 0.30, P<0.0009

Analisis korelasi Pearson telah digunakan bagi menentukan hubungan linear antara dua pembolehubah kuantitatif, iaitu pencapaian pelajar dalam kursus DBC20022 Aplikasi Komputer dan DPB20042 Sistem Maklumat Pengurusan. Dapatan menunjukkan bahawa nilai pekali korelasi Pearson ialah $r = 0.30$, dengan nilai $p < 0.0009$.

Menurut garis panduan Cohen (1988), yang digunakan oleh Pallant (2020) dalam *SPSS Survival Manual* edisi ke-7, nilai r antara 0.30 hingga 0.49 ditafsirkan sebagai hubungan yang sederhana. Oleh itu, nilai $r = 0.30$ dalam kajian ini menunjukkan bahawa terdapat hubungan linear positif yang sederhana antara pencapaian dalam kedua-dua kursus. Ini bermakna, secara umum, pelajar yang mencatat markah tinggi dalam DBC20022 cenderung untuk turut mencatat pencapaian yang lebih baik dalam DPB20042, walaupun kekuatan hubungan ini tidak begitu kuat dan juga sangat menghampiri nilai r bagi kategori yang lemah iaitu 0.29.

Nilai $p < 0.0009$ pula menunjukkan bahawa hubungan ini adalah signifikan secara statistik, kerana ia lebih kecil daripada aras signifikan konvensional $\alpha = 0.05$ dan juga $\alpha = 0.01$. Ini bermakna kebarangkalian untuk mendapat keputusan seperti ini secara kebetulan adalah sangat rendah (kurang daripada 0.09%). Maka, terdapat bukti yang kukuh untuk menolak Hipotesis Nol (H_0) iaitu tidak terdapat hubungan signifikan antara kedua-dua pembolehubah yang dikaji.

Sebaliknya, dapatan ini menyokong Hipotesis Alternatif (H_1) bahawa terdapat hubungan yang signifikan antara pencapaian pelajar dalam kursus Aplikasi Komputer dan kursus Sistem Maklumat Pengurusan. Secara praktikal, dapatan ini menunjukkan bahawa pencapaian pelajar dalam kursus asas komputer boleh dijadikan sebagai indikator awal terhadap prestasi mereka dalam kursus lanjutan. Hal ini memberi implikasi penting kepada pensyarah dan pentadbir akademik untuk memberi perhatian lebih kepada pelajar yang berprestasi rendah dalam kursus asas kerana mereka berisiko menghadapi cabaran dalam kursus Sistem Maklumat Pengurusan pada semester berikutnya.

6.0 PERBINCANGAN

Dapatan kajian ini menunjukkan terdapat hubungan linear positif yang sederhana tetapi signifikan antara pencapaian pelajar dalam kursus DBC20022 Aplikasi Komputer dan DPB20042 Sistem Maklumat Pengurusan. Secara umumnya pelajar yang cemerlang dalam kursus asas komputer cenderung untuk turut memperoleh keputusan yang baik dalam kursus lanjutan sistem pengurusan. Walaupun kekuatan hubungan tidak begitu tinggi, dapatan ini tetap penting kerana ia menegaskan peranan kursus asas dalam membina asas kemahiran ICT yang menyokong kejayaan pelajar dalam kursus lanjutan.

Keputusan ini selari dengan kajian oleh Tasir et al. (2006) yang mendapati kecekapan dalam aplikasi komputer mempunyai kaitan dengan keupayaan menyelesaikan tugasan dalam kursus yang lebih analitikal. Begitu juga, Ghavifekr et al. (2016) menegaskan bahawa pelajar yang lemah dalam asas ICT akan menghadapi kesukaran memahami topik lanjutan yang melibatkan sistem maklumat dan pengurusan data. Kajian antarabangsa oleh Lei et al. (2021) turut mengesahkan bahawa literasi komputer memberi kesan positif kepada pencapaian akademik pelajar dalam kursus berbentuk aplikasi dan sistem. Dapatan kajian ini konsisten dengan penemuan tersebut, sekali gus menambah bukti empirikal dalam konteks pelajar politeknik di Malaysia.

Dari segi implikasi praktikal, keputusan ini menunjukkan bahawa pencapaian dalam kursus asas boleh dijadikan indikator awal bagi mengenal pasti pelajar yang berisiko menghadapi cabaran dalam kursus lanjutan. Hal ini memberi peluang kepada pensyarah dan pihak pentadbiran untuk merancang intervensi awal seperti kelas pengukuhan ICT, modul digital tambahan atau sokongan akademik berbentuk bimbingan individu. Pendekatan ini selaras dengan saranan Abd Hakim (2020) yang menekankan kepentingan kompetensi digital sebagai asas literasi akademik moden.

Selain itu, dapatan kajian ini memberi implikasi terhadap reka bentuk kurikulum politeknik. Kursus asas seperti Aplikasi Komputer perlu diberi penekanan yang lebih jelas dari segi hasil pembelajaran dan kaedah penilaian agar benar-benar membina kemahiran asas yang kukuh. Strategi ini seiring dengan Dasar Revolusi Industri Keempat (4IR) dalam Pendidikan Tinggi 2021 serta Hala Tuju Transformasi Politeknik 2023–2030, yang menekankan literasi digital sebagai elemen utama kebolehpasaran graduan TVET. Dalam konteks ini, kursus prasyarat perlu dinilai keberkesanannya dan mungkin diperkukuh dengan komponen tambahan seperti latihan praktikal atau pembelajaran berasaskan projek untuk memastikan pelajar lebih bersedia menghadapi kursus lanjutan.

Akhirnya sumbangan kajian ini bukan sahaja menambah literatur berkaitan hubungan antara kursus asas dan lanjutan dalam bidang teknologi maklumat, tetapi juga memberi input bernilai kepada penggubal kurikulum dan pengajar di politeknik. Dengan menekankan kepentingan asas komputer sebagai blok pembinaan utama, dapatan ini dapat menyokong agenda nasional dalam membangunkan graduan yang kompeten, berdaya saing, dan mampu menyesuaikan diri dengan keperluan era digital. Secara keseluruhan, kajian ini menegaskan bahawa literasi digital asas bukan sahaja penting untuk kebolehpasaran graduan politeknik, tetapi juga merupakan asas kejayaan akademik sepanjang pengajian mereka.

7.0 KESIMPULAN

Kajian ini bertujuan menilai sama ada wujud hubungan signifikan antara pencapaian pelajar dalam kursus DBC20022 Aplikasi Komputer dan DPB20042 Sistem Maklumat Pengurusan. Analisis korelasi menunjukkan hubungan linear positif yang sederhana tetapi signifikan ($r=0.30$, $p<0.001$). Dapatan ini membuktikan bahawa objektif utama kajian tercapai iaitu pencapaian dalam kursus asas boleh dijadikan indikator awal kejayaan pelajar dalam kursus lanjutan.

Keputusan ini menegaskan bahawa kursus asas seperti Aplikasi Komputer memainkan peranan penting dalam menyediakan pelajar dengan kemahiran digital asas sebelum mereka mengikuti kursus yang lebih kompleks. Pelajar yang berprestasi rendah dalam kursus asas berisiko menghadapi kesukaran dalam kursus lanjutan, justeru mereka perlu dikenal pasti lebih awal. Intervensi awal seperti kelas pengukuhan ICT, modul sokongan digital atau bimbingan akademik berfokus boleh membantu meningkatkan pencapaian mereka.

Implikasi kajian ini juga melibatkan aspek kurikulum di politeknik. Kursus asas perlu diberi penekanan yang lebih kukuh dari segi hasil pembelajaran dan pendekatan penilaian bagi memastikan kemahiran yang diperoleh benar-benar menjadi asas kepada kejayaan pelajar. Hal ini seiring dengan Dasar 4IR Pendidikan Tinggi 2021 dan Hala Tuju Transformasi Politeknik 2023–2030, yang menekankan literasi digital asas sebagai teras kejayaan akademik serta kebolehpasaran graduan TVET.

Secara keseluruhan, kajian ini menyumbang kepada literatur tempatan dan antarabangsa dengan menyediakan bukti empirikal dalam konteks pelajar politeknik Malaysia. Selain itu, ia memberi input berguna kepada penggubal kurikulum dan pensyarah politeknik dalam merancang strategi sokongan akademik, di samping menyokong agenda dasar pendidikan tinggi negara. Dapatan ini juga menegaskan bahawa literasi digital asas bukan sahaja penting untuk kebolehpasaran graduan, tetapi juga menjadi asas kejayaan akademik sepanjang pengajian mereka.

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Enhancing Aquaculture Welfare: Development and Evaluation of a Fish-Friendly Restraint Device for Hormone Injection and Testis Extraction in *Clarias* sp.

Joanna W. Doinsing[1*], and Nadia Nurul Janna binti Mahmud[2]

[1,2]Department of Agrotechnology and Bio-Industry, Politeknik Sandakan Sabah, Education Hub, Batu 10, Jalan Sungai Batang, 90000 Sandakan, Sabah

joanna@pss.edu.my

Abstract

Aquaculture is a crucial industry for meeting the world's increasing demand for sustainable protein. This growth necessitates effective and ethical training, particularly in specialized procedures like hormone-induced spawning of the African catfish, *Clarias* sp. However, students often face challenges with manual fish handling, which can compromise precision, safety, and overall breeding efficiency. This study addresses this pedagogical need by introducing The Happy Spawner, an innovative fish-friendly restraint device designed to improve control and ease of handling. The device features an integrated bidet spray, head cover, water drainage, and a surgical lamp to streamline the process. A quantitative survey was conducted with a purposive sample of 82 Diploma in Aquaculture students at Politeknik Sandakan Sabah to evaluate their perceptions. A 7-item, 5-point Likert scale questionnaire was used to measure perceptions of the device's usability and functionality. Data analysis, based on 80 valid cases, showed a strong internal consistency for the scale (α=0.87). The findings revealed a highly positive overall mean score of 4.57 (SD = 0.46), which a One-Sample t-test confirmed was significantly higher than the neutral midpoint of 3.00 ($t(79) = 30.40$, $p < 0.001$). These results suggest that The Happy Spawner is a highly effective and user-friendly innovation for aquaculture practical training. The device's strong acceptance indicates its potential to significantly enhance the learning environment, boost student confidence, and better prepare them with advanced tools for the demands of the modern aquaculture industry.

Keywords: *Restraint device; tool usability; tool functionality; aquaculture education; practical training*

1. Introduction

Aquaculture has emerged as one of the most promising food production industries to meet the rising global demand for sustainable animal protein. With a projected world population of 9.7 billion by 2050, demand for animal-based protein is likely to rise by 88% (Dorling, 2021; Searchinger *et al.,* 2018). The Sustainable Development Goals (SDGs) stress the importance of addressing food security while encouraging ethical and sustainable practices (Colglazier, 2015; Troell *et al.,* 2023).

Fish welfare in aquaculture is becoming more significant due to ethical considerations as well as the desire to improve the standards and quality of fish production systems and aquaculture products. The welfare of the fish has a direct impact on their output as well as the overall sustainability of the industry. Good welfare conditions reduce stress and illness exposure in fish, lowering the need for medication and treatment (FAO, 2019). It also enhances growth rates and food conversion, resulting in higher-quality produce.

There has been a rise in interest in several finfish species for aquaculture since the world's productivity of some species has increased (Kristan *et al.*, 2018; Kucharczyk *et al.*, 2018; Teletchea, 2019). The African catfish (*Clarias* sp.) is a significant freshwater aquaculture species in Malaysia, commonly managed through artificial breeding methods like hormone-induced spawning (Dauda *et al.,* 2018; El-Hawarry *et al.,* 2016; Segaran *et al.,* 2023). Ovaprim is therefore frequently used to induce ovulation in African catfish since the resulting eggs are typically of high biological quality (Karami *et al.*, 2011; Sharaf, 2012). These procedures, however, necessitate precise and controlled handling. Manual approaches frequently pose issues in keeping constant control over the fish, resulting in operational difficulties and

decreased efficiency in breeding duties (Ali *et al.,* 2016; Mimoune *et al.,* 2023). As a result, a key pedagogical problem is that students in practical training frequently encounter these inherent handling challenges, which can hamper the smooth acquisition of critical skills. This highlights a clear pedagogical need for practical tools that offer improved usability and functionality to streamline these crucial training procedures, thereby enhancing learning efficacy (Kalyani, 2024; Çelik & Baturay, 2024).

To address this need, this study introduces The Happy Spawner: Fish-Friendly Restraint for Catfish *Clarias* sp., an innovative restraint device developed to provide better control and operational ease during breeding procedures. This device is designed with several key features that distinguish it from manual methods. It includes a bidet spray for easy cleaning of blood and other debris, a specially designed fish head cover to protect the fish during surgery and reduce stress, and a fish restraint mechanism to keep the fish stable and secure. Furthermore, the device is equipped with a surgical lamp for adequate lighting, a surgical materials drawer for easy access to tools, a water drainage system to keep the work area dry, and a compressor to supply air for the restraint mechanism. The inclusion of wheels allows for easy mobility, with a locking feature to ensure stability during use. A quantitative survey was conducted among 82 Semester 3 students in the Diploma in Aquaculture program at Politeknik Sandakan Sabah to assess their perceptions of the device's usability and functionality during practical training sessions. The findings are intended to inform future aquaculture education methods by advocating the use of highly useable and useful tools in practical learning contexts.

2. Objectives

To assess aquaculture students' perceptions of tool usability and functionality throughout practical training sessions.

3. Methodology

This study employed a quantitative research approach, which is characterized by the use of numerical data to test a theory or hypothesis (Creswell & Creswell, 2017). The purpose of the study was to evaluate student perceptions of The Happy Spawner, a fish-friendly restraint device (refer Figure 1) developed to assist aquaculture students during hormone injection and testis extraction of *Clarias* sp. The target population for this study was all Diploma in Aquaculture students at Politeknik Sandakan, Sabah, who were enrolled in the Breeding and Fry Management course. From this population, a purposive sample was drawn. The sampling criteria included students who were in Semester 3 and were actively participating in breeding activities during the study period, as they had direct, hands-on experience with the task the device was designed to address. This resulted in a total of 82 students being selected for the study (Patton, 2014).

The study's use of a purposive sampling method means the sample was selected based on specific characteristics relevant to the research question, rather than through random selection. While this method is appropriate for studying a specific group with unique expertise, the results should be regarded cautiously. The findings may not be generalizable to the larger population of aquaculture students, such as those at other institutions, due to the non-random nature of the sample selection.

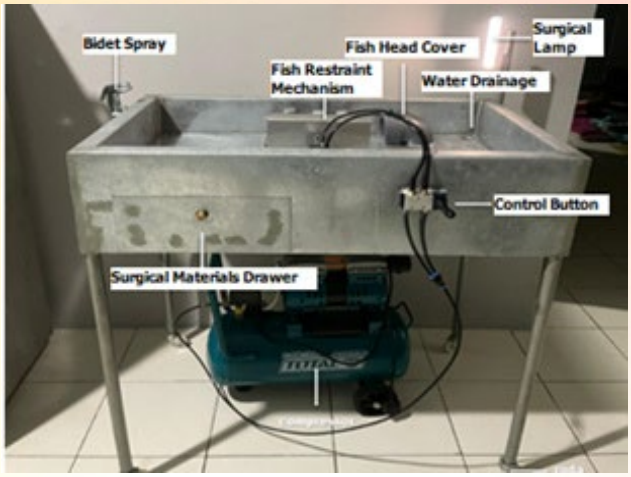


Fig. 1. The Design of Happy Spawner, A Fish-Friendly Restraint Device

The instrument used in this study was a survey questionnaire (Fowler Jr, 2013), consisting of 7 items on a 5-point Likert scale. The questionnaire measured student perceptions regarding tool usability and functionality (Joshi *et al.*, 2015). Version 27 of IBM SPSS Statistics was used to analyse the data. Descriptive statistics were used in the analysis to compute mean scores, frequencies, and percentages for every perception item (Field, 2018). For reliability analysis, Cronbach's Alpha was computed for the multi-item Likert scale measuring tool usability and functionality to assess internal consistency (Nunnally & Bernstein, 1994). For inferential statistics, a One-Sample t-test was conducted for the tool usability and functionality construct to compare its mean perception score against a neutral point (3 on the Likert scale) (Field, 2018). The overall goal of the analysis was to assess how students felt about the functionality and usefulness of the application.

4. Results

The results of the quantitative survey evaluating aquaculture students' opinions on the Happy Spawner restraint device's usability and functionality are shown in this section. It contains participant demographics, reliability analysis, perception descriptive statistics, and inferential statistics.

4.1 Demographic information

The study involved 82 Diploma in Aquaculture students. The demographic information of the respondents, including their gender, is displayed in Table 1. Female students made up 63.41% of the participants, while male students made up 36.59%.

Table 1. Demographic Profile of Respondents

Gender	Frequency (n)	Percentage (%)
Male	52	63.41
Female	30	36.59
Total	82	100

4.2 Reliability Analysis

Cronbach's Alpha was utilised to evaluate the 'Tool Usability & Functionality' scale's internal consistency. This analysis was conducted on 80 valid cases due to listwise deletion for missing data on scale items. The 7-item scale showed good reliability, with a Cronbach's Alpha

of α = 0.87. This value, exceeding the commonly accepted threshold of 0.70 (Nunnally & Bernstein, 1994), confirms that the scale used in this study is reliable and consistent in measuring student perceptions of the device's usability and functionality.

Table 2. Internal Consistency Reliability of the 'Tool Usability & Functionality'

Construct	Number of Items	Cronbach's Alpha (α)
Tool Usability & Functionality	7	0.87

4.3 Descriptive Statistics

Descriptive statistics, including means, standard deviations, and frequencies, were calculated to summarize student perceptions of The Happy Spawner's usability and functionality (based on the 7-item scale for 80 valid cases). The overall mean score for the 'Tool Usability & Functionality' construct was 4.57 (SD = 0.46), indicating that students held a strong favourable perception (see Table 3 for individual item details).

As indicated in Table 3, students expressed high levels of agreement on all included issues. For instance, the item "The use of The Happy Spawner is effective as a fish surgery aid" received the highest mean score (M = 4.66, SD = 0.62), with 70.00% of respondents 'Strongly Agreeing' and 28.75% 'Agreeing' followed by item " The 'Happy Spawner' increases the efficiency of fish restraint in fish surgery operations" with mean score (M = 4.65, SD = 0.62), with 68.75% of respondents 'Strongly Agreeing' and 30.00% 'Agreeing' and item " The 'Happy Spawner' increases the efficiency of fish restraint in fish surgery operations" with mean score (M = 4.65, SD = 0.62), with 68.75% of respondents 'Strongly Agreeing' and 30.00% 'Agreeing'. The item "The use of the 'Happy Spawner' is easy in the fish restraint process compared to manual methods" and " The 'Happy Spawner' functions well to control fish movement" both showed strong agreement (M = 4.59, SD = 0.50) and (M = 4.59, SD = 0.63), respectively. Perceptions of several practical aspects of the device, such as the ease of handling its components, its cleanability, and its ability to accelerate the surgical process, were also highly positive.

4.4 Inferential Statistics

A One-Sample t-test was conducted on 80 valid cases to determine if the overall mean perception score for the 7-item 'Tool Usability & Functionality' construct significantly differed from the neutral midpoint of 3.00 on the 5-point Likert scale. Prior to the test, the assumption of normality for the composite score was assessed; visual inspection indicated a positively skewed distribution, and the Shapiro-Wilk test was statistically significant ($W = 0.696$, $p < 0.001$), rejecting the null hypothesis of normality. Nonetheless, its use was judged appropriate due to the Central Limit Theorem's consequences and the t-test's robustness with a high sample size (N=80). The mean score (M = 4.57, SD = 0.46) was substantially higher than the neutral midpoint, according to the data, $t(79) = 30.40$, $p < 0.001$. This statistically significant finding indicates that aquaculture students held a strong positive perception regarding the usability and functionality of The Happy Spawner during practical training sessions.

Table 3. Student Perceptions of The Happy Spawner's Usability and Functionality (7-item scale, N=80)

Item No.	Statement for Tool Usability & Functionality	Mean	Std. Deviation	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
1	The use of the 'Happy Spawner' is easy in the fish restraint process compared to manual methods.	4.59	0.50	0.00	0.00	0.00	38.75	61.25
2	The components of the 'Happy Spawner' device are easy to handle.	4.40	0.65	1.25	0.00	1.25	52.50	45.00
3	The 'Happy Spawner' is easy to clean.	4.56	0.63	1.25	0.00	0.00	35.75	60.00
4	The 'Happy Spawner' device speeds up the execution of the fish surgical process.	4.53	0.64	1.25	0.00	0.00	42.50	56.25
5	The use of The Happy Spawner is effective as a fish surgery aid.	4.66	0.62	1.25	0.00	0.00	28.75	70.00
6	The 'Happy Spawner' functions well to control fish movement.	4.59	0.63	1.25	0.00	0.00	36.25	62.50
7	The 'Happy Spawner' increases the efficiency of fish restraint in fish surgery operations.	4.65	0.62	1.25	0.00	0.00	30.00	68.75
	Overall Mean: Tool Usability & Functionality	4.57	0.46					

5. Discussion

This study's primary objective was to evaluate aquaculture students' perceptions regarding the usability and functionality of The Happy Spawner restraint device, addressing known challenges in practical aquaculture education. The device was developed to streamline procedures like hormone injection and testis extraction of *Clarias* sp., which often present challenges related to fish movement and student dexterity.

The findings revealed a significantly positive perception among the participating Diploma in Aquaculture students. A One-Sample t-test revealed that students have a highly positive perspective ($M = 4.57$, $SD = 0.46$), significantly higher than neutral impressions ($t(79) = 30.40$, $p < 0.001$). This outcome indicates strong acceptance and utility of the device in practical training, aligning with calls for innovative educational tools in enhancing learning efficacy (Kalyani, 2024; Çelik & Baturay, 2024).

The consistently high mean scores, with an overall mean of 4.57 out of 5.00 for the 'Tool Usability & Functionality' construct, highlight students' strongly positive perception of The Happy Spawner. This suggests the device effectively addresses previous challenges associated with manual fish restraint during procedures like hormone injection and testis extraction (Ali *et al.*, 2016; Mimoune *et al.*, 2023). The substantial agreement across various individual items, particularly regarding their ease of use, component management, cleanability, and ability to enhance the speed of surgical procedures, strongly suggests an intuitive and well-conceived integrated design. Furthermore, the consistently high mean scores for individual items (Table 3), including the device's perceived ability to speed up surgical processes and its effectiveness as a fish surgery aid, underscore its practical benefits and alignment with its design goal to improve student control over fish movement, thereby potentially enhancing precision and safety during delicate procedures.

The overwhelmingly positive student impressions of The Happy Spawner have important implications for aquaculture teaching. By being viewed as simple to use and effective, the device generates a more confident and effective learning environment for students. This tool also supports educators by facilitating clearer instruction and potentially improving the consistency of practical skill acquisition among students. Ultimately, these findings strongly support the notion that well-designed practical tools can significantly enhance educational outcomes in specialized fields like aquaculture by streamlining crucial training procedures and empowering learners (Kalyani, 2024; Çelik & Baturay, 2024). This success suggests that integrating such innovative restraint devices into aquaculture practical training curricula is a valuable step, preparing students with advanced tools for the demands of the modern aquaculture industry.

Despite the positive findings, this study has several limitations. A significant limitation lies in its sampling methodology; the reliance on purposive sampling means the generalizability of these results is limited to the specific cohort of Diploma in Aquaculture students studied at Politeknik Sandakan Sabah (Creswell & Creswell, 2017; Patton, 2014). This non-random approach suggests that the findings regarding the device's usability and functionality should be interpreted as specific to this group, and direct generalization to broader student populations or other educational institutions should be made with caution.

Additionally, while the One-Sample t-test is robust for large sample sizes, the composite score for 'Tool Usability & Functionality' exhibited a positively skewed distribution, as revealed by normality tests (Shapiro-Wilk $W = 0.696$, $p < 0.001$)). This deviation from normality needs interpretation within the Central Limit Theorem's boundaries, which supports the t-test's

robustness despite this assumption violation given the high sample size (N=80) (Field, 2018; Pallant, 2020).

Future research could build on the current findings and solve noted limitations by investigating bigger, more varied, and randomly selected groups to improve the generalizability of the results. It would also be beneficial to undertake long-term research to assess the influence of The Happy Spawner on student skill acquisition and retention when compared to traditional techniques. Furthermore, in-depth studies exploring students' specific experiences and challenges with both the device and manual handling could provide deeper insights into user perceptions.

To further understand the device's broader impact, future studies could compare student performance (e.g., speed, injury rates) using The Happy Spawner versus traditional fish restraint methods. Research could also assess instructor perceptions of the device or evaluate its effectiveness in different aquaculture settings or with various fish species. Exploring the various factors influencing student adoption and sustained use of such technological aids in practical training would also be a fruitful area for further inquiry.

6. Conclusion

This study aimed to determine aquaculture students' perceptions of the usability and functionality of The Happy Spawner restraint device. The results clearly show that the participating Diploma in Aquaculture students had a very positive view, with an overall mean score of 4.57 out of 5.00. This strong positive opinion demonstrates the device's widespread acceptance and perceived utility in practical training, implying that it efficiently addresses existing issues in manual fish restraint.

The findings highlight The Happy Spawner's intuitive design and practical benefits, describing it as simple to use, efficient, and beneficial in facilitating fish surgery. This strong positive opinion has important implications for aquaculture education, since the device has the ability to reduce student anxiety, standardise training processes, and improve practical skill development. Finally, the findings give strong support for incorporating such novel technologies into the curriculum, which will better prepare students for the evolving demands of the modern aquaculture industry.

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Hardness Characteristics of Thin-Layer Gas Diffusion Hybrid S Phase Using Numerical Simulations

Rafidah Laili Jaswadi[1], Mohammad Firdaus Mohammed Azmi[1]*

[1]Department of Mechanical Engineering, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

*Corresponding author's email: firdaus_azmi@polikk.edu.my

Abstract

The hybrid S phase is a hardened surface layer formed on austenitic stainless steel through low-temperature heat treatment in the presence of nitrogen and carbon. This study investigates the hardness characteristics of a thin-layer hybrid S phase developed using low-temperature gas diffusion, through both experimental nanoindentation and numerical simulations. Nanoindentation test was modelled using ABAQUS finite element software, with a 3D Berkovich indenter created in a 3D modelling software. A simplified one-third model was used to reduce computational cost, applying cyclic symmetry and nonlinear large-strain elastoplastic behavior. The material properties for 316LVM stainless steel were applied, and the simulations accounted for surface-to-surface contact and friction. Findings revealed that the hardness reaction depends heavily on the composite mechanical response of the thinning S phase as well as the substrate. The experimental results of the nanoindentation have been well supported under finite element simulations, which facilitated the level of successful isolation of the property of the surface layer. The results prove the usefulness of gaseous diffusion methods in the formation of hard surface layers and the importance of modeling in avoiding some of the drawbacks of the experimentation. The study helps to shed more light on S phase mechanical performance and thus its use in activities like biomedical, automobile and marine engineering..

Keywords: *316LVM stainless steel, hybrid treatment, Hardness, Nanoindentation*

Introduction

A hardened, thin surface layer known as S phase layer is produced when austenitic stainless steel is subjected to nitrogen and carbon and undergo a low-temperature heat treatment process. The treated stainless steel is most common in the biomedical, automotive, fluid handling, mechanical fastening as well as the marine industries owing to its optimized surface characteristics as compared to an untreated stainless steel. Some of the methods of creating this layer include plasma diffusion (Sun, 2005), ion implantation (de Oliveira et al., 2018), liquid diffusion (Jiang et al., 2018), and gas diffusion (Azmi et al., 2022; Saedon et al., 2020). In the past, gas diffusion in the formation of S phase on the austenitic stainless steels was said to be ineffective mainly because of the presence of an oxide layer of the surface that hinders the diffusion of nitrogen and carbon. Nevertheless, there are other oxide removal processes that have found use to change this hurdle which are cathodic sputtering, fluoride solution treatment and hydrochloric acid cleaning. Its evidence that when effectively used, gas diffusion can be used successfully to form well-developed hybrid S phase layer in low-temperature nitriding and carburizing, something that had been otherwise argued against its effectiveness. Saedon et al. were able to successfully develop the gas diffusion Hybrid S phase where the layer resulting was roughly 13.3m with controlled parameters such as temperature, holding time and nitrogen and carbon composition (Saedon et al., 2020).

Nanoindentation is a widely used application in analyzing the criteria of elastic and plastic deformation in thin films, and substrates and material characterization in terms of hardness and elastic modulus. The deformation mechanics of such thin layers require an understanding of their mechanical strength to analyze failure conditions of a thin-film structure.

A similar case has been seen where indentation testing using low loads with a Berkovich tip has been used as a useful means of evaluating the mechanical behavior of films and coatings. Besides supplying results of hardness, such methods can be used to estimate the useful information concerning the near-surface mechanical behavior and the deformation of both coatings and bulk materials (Asgari et al., 2011).

The nanoindentation was performed at various depths from 100 to 1750 nm on all treated samples in order to evaluate the evolution of hardness with depth into the nitrided layer. The measured hardness increases as the indentation depth decreases. At depths greater than about 700 nm the hardness value stabilized to around 3.8GPa and correlating well with values obtained by conventional microindentation. The elastic modulus and hardness of gas nitrided austenitic stainless steel obtained by analyzing the load- displacement curves analysis-based Oliver and Pharr's elastic contact (Baranowska et al., 2005). Asgari et al. investigate nanomechanical properties of pulsed plasma nitrided 316L stainless steel and found a drastic increase in the dislocation density (Asgari et al., 2011). The elasto-plastic loading and elastic unloading parts of the curves also changed significantly due to the combined effect of interstitial nitrogen and increased dislocation density.

Hybrid S-phase treatments have been widely recognized for enhancing the surface mechanical properties of austenitic stainless steels, particularly in terms of nanohardness and elasticity. (Juri et al., 2023; Kurdi et al., 2024) demonstrated that thermomechanical heat treatment at 475 °C using methane as the carbon source significantly improved the nanohardness of untreated 316L stainless steel from 2.33 GPa to as high as 14.65 GPa, along with a substantial increase in Young's modulus from 83.25 GPa to 142.34 GPa. Similarly, Triwiyanto et al. (2013) applied a hybrid heat treatment involving ammonia and methane at 400–450 °C for 8 hours, reporting a qualitative increase in hardness by 4–5 times and a noticeable reduction in plastic deformation. These treatments also led to microstructural changes such as slip bands, stacking faults, and duplex layer formation. Both studies confirmed that the S-phase layer promotes a transition from plastic to elastic deformation, enhancing resistance to wear and surface damage under mechanical stress. Nevertheless, neither of the studies used finite element modeling, although both studies had high emphasis on experimental analysis, confining the analysis of stress and strain fields under mechanical loading into the subsurface.

Nanoindentation modeling of thin-film coating and bulk solid materials using a finite element method (FEM) has emerged as one of the major methods in the characterization of the mechanical responses of materials. In contrast to experimental technique, FEM gives the insight into the distribution of stresses and strains underlying the tip of an indenter which are hard to measure directly. This is essential information to ascertain basic properties like hardness, yield strength and the effect of indenter geometry. FEM has proved to be applicable in numerous materials over the years such as metals (Alaboodi & Hussain, 2019) and polymers (Diaz-Pascual et al., 2015). It can be used to aid in developing superior material design and coating performance, as the constitutive relationship allows it to be used to simulate realistic deformation modeling behavior. Consequently, FEM has emerged to be a very essential method in materials characterization and analysis in the realm of mechanics.

Despite the usefulness of experimental methods to analyze mechanical behavior of the S-phase layer, finite element modeling (FEM) is still comparatively rare with regards to this topic. FEM is also an efficient method when the deformation behavior during nanoindentation is exceptionally complex or the response of the substrate dominates the experimental measurement in the case of a thin film system. Although (loading, indentation response, stress

distribution, Shell-to-shell and/or layer-to-layer responses) both (Kurdi et al., 2024) and (Triwiyanto et al., 2013) show that the nanohardness values crash experimentally, the absence of FEM in the investigations, however, cannot allow the detection of a complete picture of the strain distributions, layer-specific behaviors, and of the role of geometry applied at indentation. FEM would lead to the possibility of decoupling the behavior of the hybrid S-phase layer and the bulk substrate and be able to predict different treatment parameters, geometries, etc. Thus, the application of FEM together with nanoindentation experiments may provide a more complete picture of the mechanical behaviour and optimisation of the design of S-phase-strengthened stainless steels. This will bring benefit especially to the biomedical applications. The proposed study will define the thin layer hybrid S phase layer, formed through gas diffusion low-temperature process in terms of the mechanical properties including hardness, elasticity, and nano scratch resistivity by experimental and the finite element analysis methodologies.

Methodology

Finite element modelling

ABAQUS finite element simulation was undertaken to simulate the behaviour to study nanoindentation of a hybrid S-phase layer on 316LVM stainless steel. The simulation was done in large-strain elastoplasticity that was effective in describing material deformation. An accurate 3D design of the Berkovich indenter created in SolidWorks that would replicate the experimental system was imported to ABAQUS. In order to minimise computational costs without sacrificing model fidelity, the simulation domain was truncated to one-third of the complete geometry and the cyclic symmetry of a Fig. 1.

The Berkovich indenter was modeled as a rigid body, while the specimen was assigned isotropic linear-elastic properties of 316LVM stainless steel, with an elastic modulus of 187.55 GPa and a Poisson's ratio of 0.33. Plasticity was defined using a true stress–plastic strain curve derived from experimental data. The model consisted of 87,601 nodes and 80,244 elements, with reduced integration linear hexahedral elements (C3D8R) used throughout. A load-controlled indentation of 0.2 mN was applied to the indenter tip, followed by unloading to simulate recovery. The bottom surface of the specimen was fixed using an *encastre* boundary condition. A surface-to-surface contact interaction was defined between the indenter and the specimen surface, using a penalty contact method with a Coulomb friction coefficient of 0.1 to minimize sliding. The simulation was performed under quasi-static conditions, neglecting inertia and time-dependent effects, and solved using ABAQUS Standard with nonlinear geometry enabled.

However, it is noted that the model usually assumes a perfectly sharp Berkovich. A real tip has a finite apex radius and edge blunting, which increases real contact area at low loads, reduces peak pressure, promotes pile-up, and leads to shallower apparent hardness depths; the sharp-tip model therefore underpredicts pile-up and can overestimate hardness/modulus from unloading.

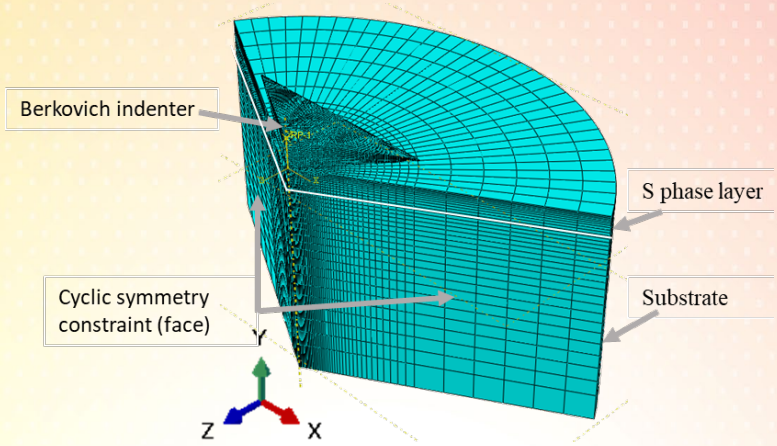


Fig. 1: illustrates the meshed model with clear annotations of the Berkovich indenter, cyclic symmetry boundaries, refined mesh region under the indenter, and fixed base condition.

Nanoindentation Experimentation

Nanoindentation experiments were conducted using the IBIS nanoindentation system (Fischer-Cripps Laboratories, IBIS), equipped with a Berkovich diamond indenter to evaluate the mechanical properties at the microscale. Prior to testing, the instrument was carefully calibrated using a fused silica standard sample to ensure measurement accuracy and to correct for any machine compliance. All indentation tests were performed under load-controlled mode, applying a maximum load of 20 mN with a constant loading and unloading rate of 0.5 mN/s. This controlled loading profile was selected to minimize dynamic effects and to maintain consistency throughout the testing process. To achieve reliability in statistical data analysis and reproducibility of data, at least five individual indentations were carried out on each sample taken under the same conditions. Load displacement curves thus obtained were analyzed and the values reported as the average of these readings which are parameters of hardness and modulus with their standard deviations to reflect variation in the experiment.

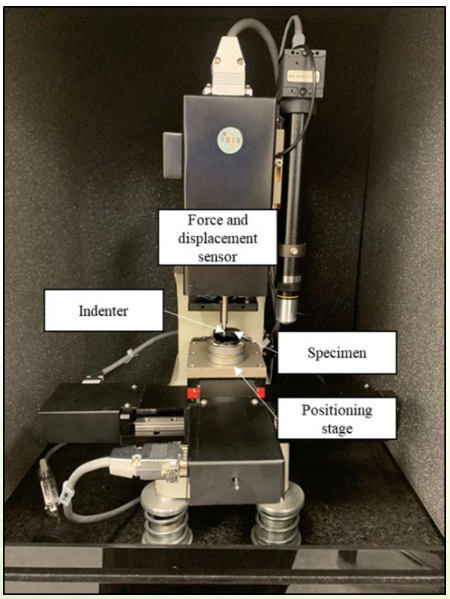


Fig. 2: Nanoindentation apparatus by Fischer-Cripps Laboratories, IBIS

Results

Load-displacement diagram

Untreated 316L stainless steel, and S-phase-treated 316LVM stainless steel nanoindentation behavior under the same peak load of 20 mN are compared using the load/displacement (L-D) curves in Fig.3 by both experimentation and a finite element analysis (FEA). The discussion can provide good insight of how hybrid S-phase treatment affects the ability of surface to impart mechanical behavior which includes hardness, stiffness and even elastic recovery in a surface.

Among the samples in the experiment, the maximum displacement of the untreated 316L sample was about 0.52 µm whereas the maximum indentation depth of the S-phase treated 316LVM was smaller being about 0.26 µm. This displacement decrease by almost 50 percent under the same loading is also a clear evidence of huge increase in surface hardness brought about by the S-phase layer. In addition to that, the unloading slope of the sample, which was treated by S-phase, is sharper, which means that its elastic modulus is larger, and its elastic recovering is better. The given findings can be compared with the findings in similar works like (Kurdi et al., 2024) that stated the nanohardness went up and improved to 14.65 GPa and Young modulus also improved to 142.34 GPa due to S-phase treatment.

The FEA results are in strong agreement with the experimental trends. The 316L model recorded a maximum displacement of 0.50 µm, while the S-phase model reached a maximum depth of 0.27 µm under the same 20 mN load. The FEA simulation thus predicts a displacement reduction of approximately 46%, closely matching the experimental behavior. The improved stiffness and lower penetration depth of the treated model validate the accuracy of the material property assignment and boundary conditions applied in the simulation. A key observation is the consistent behavior of both materials across experiment and simulation. In both untreated and treated conditions, the simulation slightly underestimates displacement compared to experimental data, which may be attributed to the idealized geometry, perfectly bonded interfaces, and homogeneous material properties assumed in the finite element model. Nonetheless, the trend and magnitude of mechanical response are well captured. The difference in the shape of the unloading curves further emphasizes the mechanical enhancement due to S-phase treatment. The steeper slope of the S-phase-treated curves (both experimental and FEA) indicates a shift towards elastic-dominant deformation and reduced plasticity, in agreement with SEM observations and displacement contour plots from previous simulations.

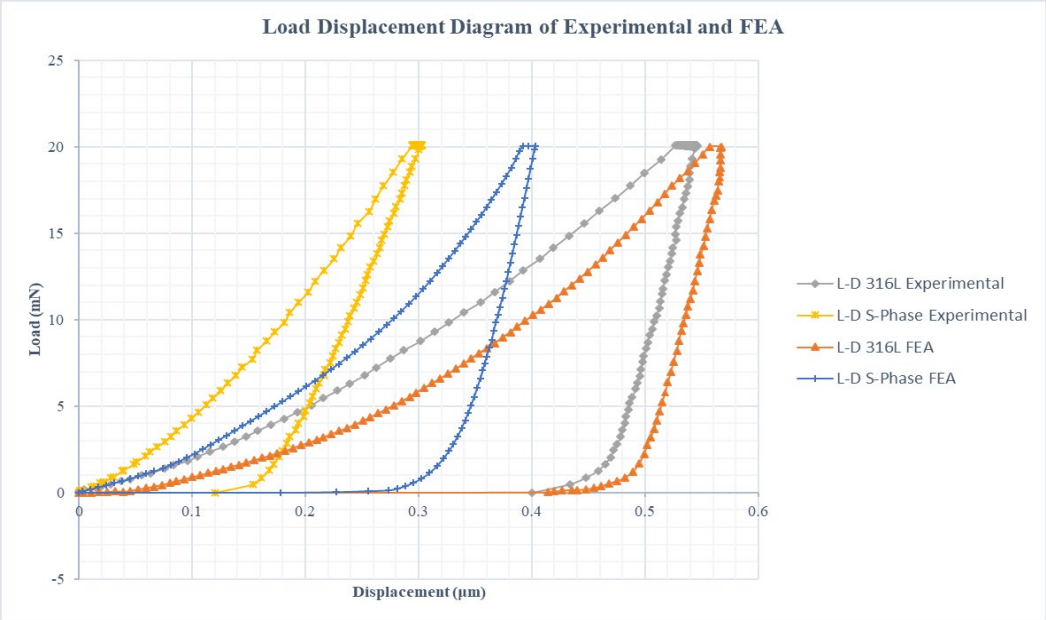


Fig. 3: Load-Displacement diagram of untreated 316L stainless steel and S-phase-treated 316LVM stainless steel under 20 mN load.

Analysis of surface deformation: Comparison between experimental and numerical results

Comparative assessment of simulated and experimental nanoindentation profiles for untreated 316LVM stainless steel and S-phase-treated 316LVM is presented in **Error! Reference source not found.**. Sub-figures (a) and (b) correspond to the untreated sample, while (c) and (d) depict the treated condition. Finite element simulation displacement contours are shown on the left-hand side (a) and (c), while scanning electron microscope (SEM) images of the residual indentation marks are presented on the right-hand side (b) and (d). The displacement behaviour and deformation geometry were assessed to analyse the effectiveness of the S-phase treatment.

The FEA results (**Error! Reference source not found.**a) indicate a broader and deeper displacement field with a maximum displacement of 0.567 µm. The stress is distributed more widely into the substrate, suggesting lower material stiffness and higher susceptibility to plastic flow. This is consistent with the SEM observation (**Error! Reference source not found.**c), where the indentation appears significantly deeper with less defined edges and visible evidence of material pile-up. This observation is validated because the untreated sample experiences more plastic deformation and low contact induced stress resistance. The simulation result (Fig. 4b) on the S-phase-treated material confirms monotonous displacement area (as the indenter is not penetrated) under the indenter, but the total displacement is relatively great and has the maximal possible value of about 0.403 m. The displacement contours are crowded and very localized which indicates great surface resistance to plastic deformation. Identical results are indicated by the experimental SEM image (Fig. 4d), showing a sharp triangular and shallow indent with little to no pile-up or surface damage and a steep angle face. This reaffirms that the hybrid S-phase layer has good advantages of having enhanced surface hardness and preventing permanent deformation under 20 mN load.

The high level of consistency between the displacement analysis of FEA and SEM images confirms soundness of the simulation model at characterising the mechanical behaviour of untreated and treated specimens. Change in mechanical performance is higher on the S-phase-treated surface, which is depicted by lower displacement, steeper indentation, and limited

deformation area. Such findings confirm that hybrid S-phase treatment mediates significant increase in hardness and elastic recovery properties of 316LVM stainless steel. However, the comparison between FEA and experimental nanoindentation reveals that while both methods consistently show the S-phase treated 316LVM having higher hardness and lower penetration depth compared to the untreated steel. The geometry of the indents differs noticeably. The experimental SEM images display uneven edges and clear pile-up around the indent, especially for untreated 316LVM, due to real factors such as tip rounding, surface roughness, residual stresses, and complex plastic deformation mechanisms. In contrast, the FEA results produce smooth, symmetric indent profiles with no pile-up because of idealized assumptions, including perfectly sharp indenter geometry, homogeneous material properties, and simplified contact conditions. This explains why experiments capture more localized plastic flow, whereas simulations emphasize idealized, uniform deformation.

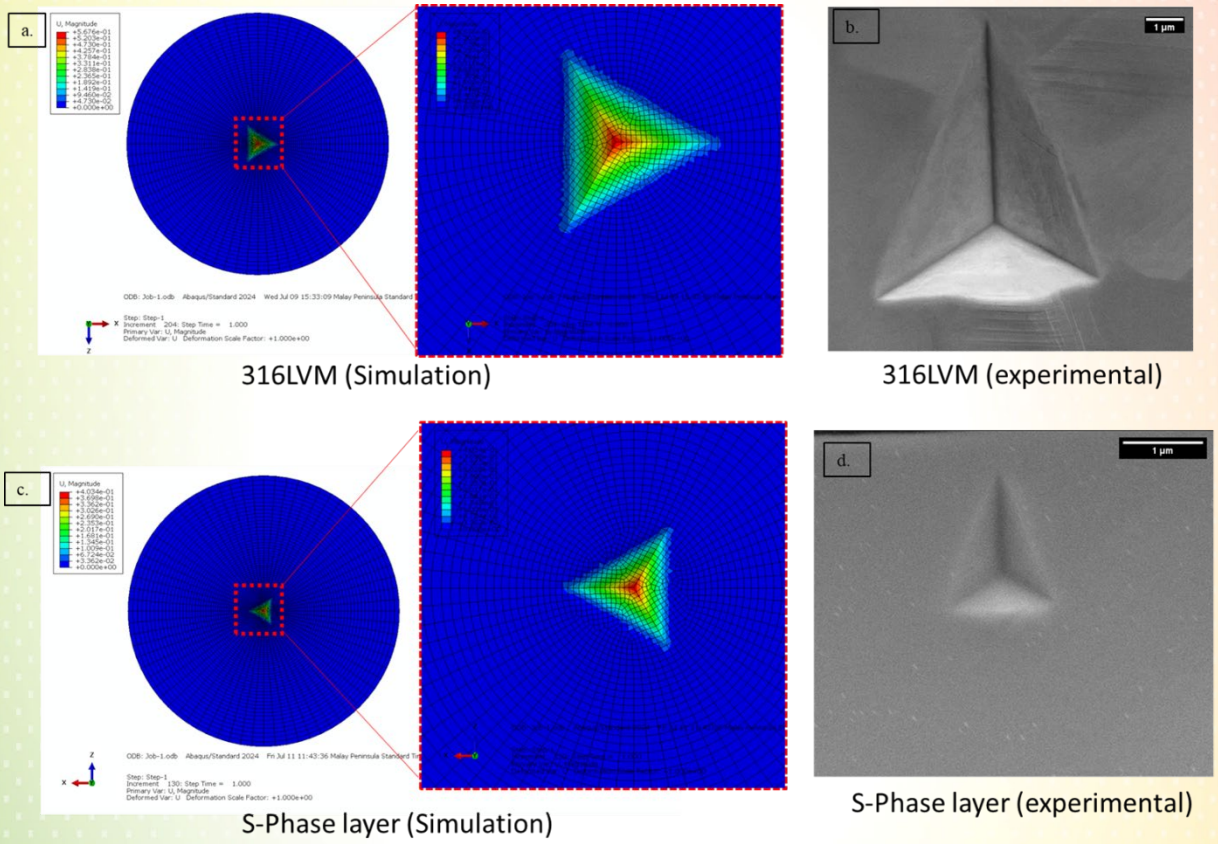


Fig. 4. Visual Comparison between Simulation and SEM of indentation profile

Von Mises Stress Distribution and Plastic Zone Analysis

The von Mises stress contours resulting from finite element simulation of nanoindentation at a 20 mN peak load for untreated 316LVM stainless steel and S-phase-treated 316LVM are presented in **Error! Reference source not found.**. The von Mises stress criterion is widely used to evaluate yielding behavior under complex loading conditions and serves as a robust indicator of material strength under indentation. In the untreated 316LVM sample, the maximum von Mises stress reaches 0.707 GPa, concentrated directly beneath the indenter tip and spreading outward. The stress contours extend deeply into the material, indicating that the untreated sample undergoes significant plastic deformation over a larger volume. This wider stress field aligns with the higher principal plastic strain and greater displacement observed in the untreated sample, highlighting its relatively lower mechanical resistance.

The 316LVM S-phase treated sample has a greater peak value of von Mises stress of 0.786 GPa which indicates that the material has greater capacity to resist localized loading prior to giving way. The maximum-stress band is narrower spaced under the indenter and with less lateral spreading giving a more confined plastic flow. It can be concluded that this more focused and severe stress distribution on a local scale is caused directly by the hardened layer of S-phase and makes the material underuse tougher and more resistant to piercing. It further confirms the strengthening of the S-phase layer as when compared with the treated sample, there was an increase in maximum von Mises stress of about 11%. These results obtained in the simulation are in support of the experimental data, which proves the conclusion that low-temperature S-phase treatment has remarkably improved the mechanical properties and augmented the yield strength of 316LVM stainless steel and decreased the level of plastic deformation at nanoindentation.

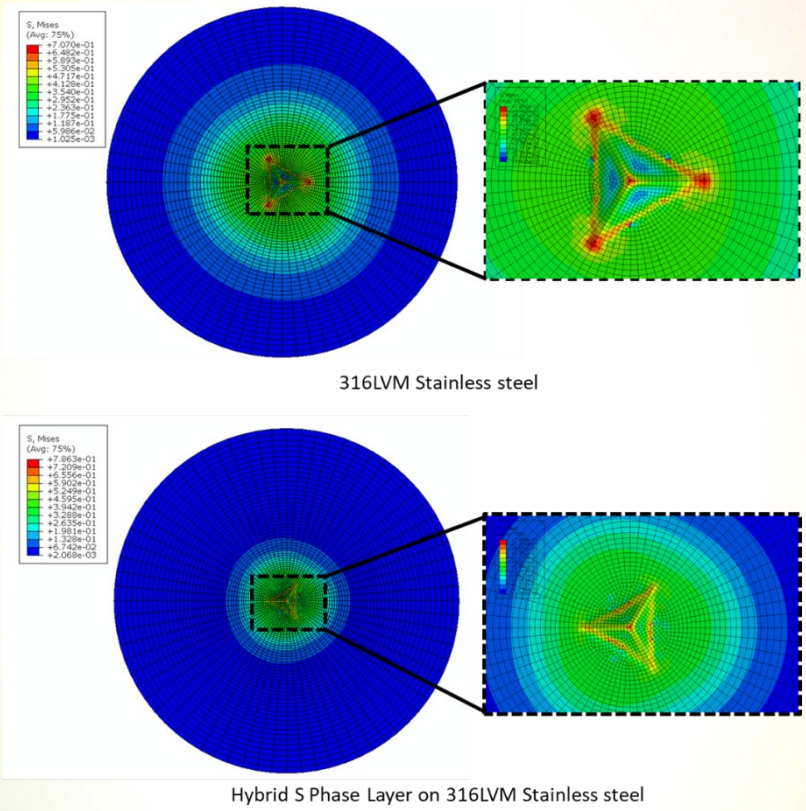


Fig. 5: Von Mises Stress Distribution

Maximum Principal Plastic Strain

The maximum principal plastic strain distribution from finite element simulations of nanoindentation on both untreated and S-phase-treated 316LVM stainless steel under a 20 mN load are shown in **Error! Reference source not found.**. These strain contours illustrate the severity and spread of plastic deformation in response to localized mechanical loading. In the untreated 316LVM sample, the simulation shows a peak principal plastic strain of approximately 0.4223. The plastic zone is broad, with strain propagating deeply and laterally from the indentation site. The triangular high-strain region spreads extensively into the substrate, indicating that the material yields easily and undergoes substantial permanent deformation. This broad and deep strain field characterize a softer material and has lower yield strength and is congruent to the previous findings of greater displacement and greater depth of indentation with both experimental and numerical simulations.

Comparatively, the treated 316LVM in S-phase has a lesser plastic region with the peak principal strain being 0.3453. Whereas the characteristics of the strain field of both samples are much similar in the same loading condition, the treated sample shows considerably narrow and shallow strain field implying a superior resistance to plastic flow. Accumulated deformation is confined and localized in the interphase between the hybrid S-phase layer and the indenter with small strain transfer into the substrate. This is an expression of the hardness on surfaces and the yield strength boost that the S-phase treatment brings. Therefore, the less critical peak strain and a more localized point of deformation in the treated sample certify the positive impact of the layer of the S-phase on a positive effect on the mechanical performance. The treatment improves strength on the surface and enhances the resistance to plastic deformation in the subsurface as well thus, has the potential of being used as a surface engineering approach in enhancing wear and carry-load of biomedical-grade stainless-steels.

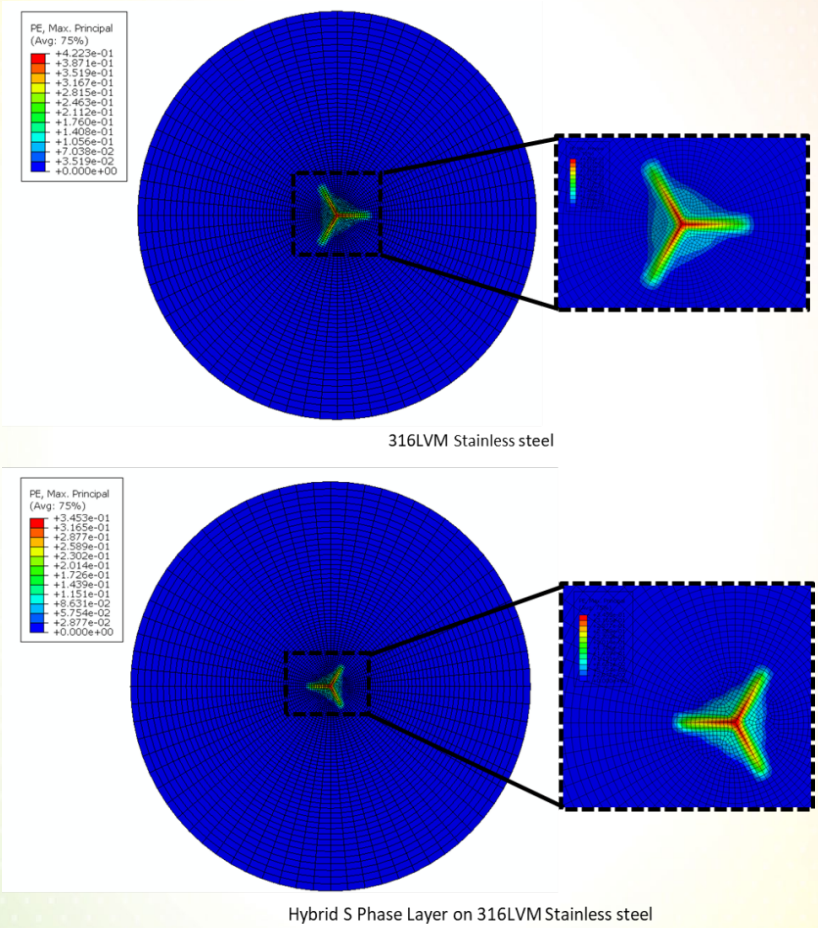


Fig. 6: Maximum Principal Plastic Strain Distribution

Conclusions

The low-temperature hybrid S-phase surface treatment has been proven in this study to enhance the surface hardness of 316LVM stainless steel. Nanoindentation testing and modeling using finite element analysis (FEA) have shown the observable difference in the mechanical response of untreated and S-phase-treated samples. The 316LVM which underwent treatment in S-Phase also showed decreased maximum plastic strain of 0.3453 as compared to 0.4223 of the untreated specimen implying that it is resistant to plastic deformation. Also, due to the FEA results, von Mises stress analysis indicated higher peak stress in the treated material

(0.786 GPa) than the untreated steel (0.707 GPa), reflecting a strengthening effect as a result of the S-phase layer. Both experimental and numerical results are well correlated and they suggest that the hardness of the treated samples is increased and that both values have increased indentation depth and local deformation. This is also reinforced by the load-displacement phenomena that represented lesser penetration depths of the S-phase-treated 316LVM below the same 20mN peak load. All these observations verify that the S-phase treatment enhances the surface hardness of stainless steel 316LVM among other properties significantly, rendering it an attractable means of increasing the wear resistance and durability of biomedical and engineering material.

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Production and Performance Testing of Water Purification Devices based on Solar Panel

Pande Putu Agus Santoso[1*], Budi Setiawan[2], Ari Rianto[3]

[1,2,3]Department of Mechanical Engineering, Politeknik Negeri Sambas
Jalan Raya Sejangkung, Sambas, 79462, Kalimantan Barat

*Corresponding author's email: pande.santoso@gmail.com

Abstract

River water was the main source of daily life for the people of West Kalimantan, especially in Sambas Regency. However, the fact was that the quality of river water was still below the standards of clean water. This was due to the high content of sand, silt, and dissolved particles in the water. This research aims to describe the results of the production and explain the performance test results of the solar panel-based water purifier. This type of research was experimental research. The dependent variables are the pH and TDS values of the water. The independent variable was the treatment applied to the research samples, where the experimental group (water after filtration) and the control group (water before filtration). Research results show that a solar panel-based water purification device measuring 76 cm in length, 76 cm in width, and 140 cm in height has been successfully created. This device was equipped with nine filtration tubes containing coir, sea shells, zeolite sand, activated charcoal from coconut shells, activated charcoal from rice husks, beach sand, and microfiltration of sizes 10µm, 0.5 µm, and 0.1 µm. After passing through nine filter tubes, the water was also sterilized electrically using a UV water sterilizer. The UV water sterilizer and the water pump are powered by electricity from the solar panel. The performance test results of the water purification tool with the solar panel electricity source show that this tool was capable of improving water quality. It was known that the input water has a murky colour, an average pH value of 7.9, and an average TDS value of 74 ppm. After passing through this tool, the water becomes clear, with an average pH value of 6.8 (neutral) and an average TDS value of 126 ppm (meeting WHO standards and the Minister of Health Regulation No. 31 of 2017).

Keywords: *device, performance testing, production, solar panel, water purification.*

1. Introduction

Water is a basic necessity for people in everyday life. Water that is suitable for use meets the criteria of physics, chemistry, and biology (Prasad and Grobelak, 2020). The criteria for clean water in terms of physics are that the water must be clean, not cloudy, colourless, tasteless, odourless, with a temperature between (10-25)°C, and must not leave any sediment. The criteria for clean water chemically are that it does not contain toxic chemicals, does not contain excessive chemical substances, has sufficient iodine, and a pH level of water between 6.5-9.2. The criteria for clean water biologically are that it does not contain disease-causing germs such as dysentery, typhoid, cholera, and pathogenic bacteria that cause diseases (Rafique, 2025).

River water is the main source in the daily life of the people of West Kalimantan, especially in Sambas Regency. However, in fact, the river water still falls below the water quality standards set by the Government Regulation of the Republic of Indonesia No. 22 of 2021. Physically, the water has a murky colour due to the high content of sand, mud, and particles dissolved in it. Chemically, the pH of the water in Sambas Regency is acidic, ranging from a pH concentration of 4.78 to 6.75 (Maulina et al., 2022). Based on this, it is deemed necessary to carry out efforts to purify water.

The water purification process can generally be classified into two, namely mechanical and electrical. The mechanical water purification process was carried out by flowing water through

gravel and sand (Muhamed et al., 2016). Apart from sand and gravel, this mechanical water purification system also uses palm fibbers and activated charcoal (Ahmed, 2019). The advantages of this method are that it is very effective in purifying water and is relatively cheap and does not require electrical energy. The disadvantage is that there is still a chance of bacteria, moss and fungi escaping through the mechanical filtration process.

The electrical purification process is carried out by irradiating water using ultraviolet light. The advantage of this system is that it is able to carry out the sterilization process up to the microbiological level. Dumayas et al (2018) has successfully designed and built a bio sand filter system equipped with ultraviolet lamps. The test results show that the water obtained meets the standards of the bio sand filter filtration process only, only meets the standards as clean water physically and chemically. The results of testing drinking water produced through the bio sand filter process, reverse osmosis and sterilization (ultraviolet light) declared fit for consumption because it is clean microbiologically, chemically and physically. The weakness of this system is that it requires electrical energy to turn on the ultraviolet lamp.

Based on this, it is deemed necessary to develop a water purifier that is able to combine the advantages of mechanical and electrical methods, and minimize the disadvantages of each method. The advantage of the mechanical method is that the filtering process is simple because it only flows water through various types of layers, unfortunately it is still maintained. The disadvantage of the mechanical method is that it is not yet able to kill microorganisms, which will be overcome by the advantages of the electrical method, through the use of ultraviolet lamps. The disadvantage of the electric method, namely having to turn on ultraviolet lights, will be overcome by the presence of a solar power generation system on the tool to be developed. In addition, electrical energy from solar panels for water pumps. Arifin et al (2024) has successfully utilized solar panels in community-based drinking water processing. Beside that Waris and Ghaith (2022) has succeeded in designing a solar powered drinking water treatment device with a capacity of 50 m^3/day. It is believed that by using a hybrid water purifier (a combination of mechanical and electrical methods) based on solar panels, the weaknesses of the mechanical and electrical methods will be overcome and the advantages of each method will still be accommodated.

3. Organization of the Text

2.1 Tool Design

The design of a water purifier based on solar panel electrical energy can be seen in Figure 1 below.

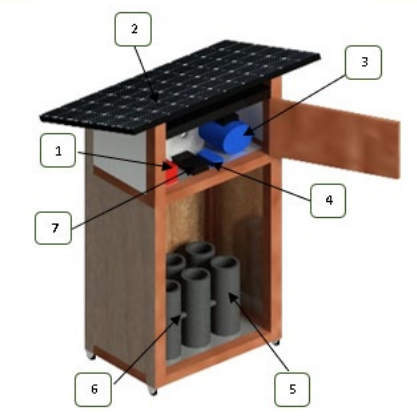


Figure 1. Design of a water purifier based on solar panel electrical energy

Based on Figure 1, the caption are:

1. Battery.
2. 100 Wp solar panel.
3. Water pump.
4. SCC.
5. Water filter (silica sand, manganese, activated carbon, water tech 10, 5 and 1 µm).
6. UV filtration.
7. Inverter.

Based on Figure 3.2, the hypothesis of how the tool works is as follows. When sunlight hits the solar panel, the total sunlight will cause the movement of electrons (electric current) from the solar panel to the battery through the solar charge controller (SCC). The SCC functions to reduce the voltage to match the battery voltage, which is 12 V. The electric current generated by the solar panel is stored in the battery. The electric current from the solar panel and battery is direct current or DC. This DC current is converted into AC current by the inverter. The output current from the inverter is AC electric current. The current from this inverter is used to turn on the pump and ultraviolet reactor.

The pump will flow water from the reservoir to tube 1 (coconut fiber). By utilizing the concept of hydrostatic pressure and gravity, water from the bottom of tube 1 will go to tube 2 (sea shells). Water from tube 2 will go to tube 3 (zeolite sand). Water from tube 3 will go to tube 4 (activated charcoal from coconut shells). Water from tube 4 will go to tube 5 (activated charcoal from rice husks). Water from tube 5 will go to tube 6 (beach sand). Water from tube 6 will go to tube 7 (10 µm microfilter). Water from tube 7 will go to tube 8 (0.5 µm microfilter). Water from tube 8 will go to tube 9 (0.1 µm microfilter). Water from tube 9 will go to the ultraviolet reactor tube (UV water sterilizer). In the ultraviolet reactor, water will be irradiated with UV light to kill germs. Furthermore, water from the ultraviolet reactor tube will go to the output hose.

2.2 Calculation of solar panel components

The research material collection stage begins with carrying out calculations to determine the characteristics of the panel, battery and SCC required.

a) Determine the electrical power requirements of the water purifier.

This water purifier utilizes solar panels to generate electrical energy which is used to power 1 water pump with a power of 50W and 1 UV water sterilizer 6W. This tool will be used for five hours (10.00 am to 03.00 pm). The total power requirement (P) is calculated using equation (1), as follows.

P = [(50W + 6W) x 5h = 56W x 5h = 280Wh.

b) Determine the capacity of the solar panel (PV).

Determining the panel capacity can be done using equation (2), as follows.

PV = P : 5

PV = 280 Wh : 5 h = 56 Wp.

So it is necessary to provide a solar panel with a minimum power of 56 Wp. However, because a solar panel with a power of 100 Wp is available, this study uses a solar panel with a power of 100 Wp.

c) Determine the SCC capacity
The 100Wp solar panel has the following characteristics.
Pm = 100 Wp
Vm = 18 Vdc Voc = 22,32 V
Imp = 5,65 A Isc = 5,94A

Because this research only uses one solar panel, to determine Iscc and Vscc, we use equation (3) as follows.
Iscc ≥ Isc panel.
Vscc ≥ Voc panel.
So SCC 10A was chosen. SCC 10A has fulfilled the equation (3) principle, where it has Iscc (10A) > Isc panel (5.94A) and Vscc (50V) > Voc panel (22.32V).

d) Determine the battery capacity.
The battery capacity is determined using equation (4) as follows below.
Battery Capacity (Ah) = 1,5 x P
Battery Capacity (Ah) = 1,5 x 280W = 480W.
So it is necessary to provide a battery with a minimum specification of 12V 35 Ah.

However, because a battery with a specification of 12V 65Ah is already available, this study uses a 12V 65Ah battery.

2.3 Performance Test Methods

Testing of the tools developed in this study was conducted experimentally. The research variables in the experimental testing process are as follows.

a) Dependent variable
The dependent variable in this study is the pH and TDS values of clean water produced by the device.
b) Independent variable
The independent variable in this study is the form of treatment of the research sample, where the experimental group (water filtered using the device) and the control group (water before filtration).

The performance test method consists of data collection techniques and data analysis techniques. The data collection techniques in the study entitled water purifier with a solar panel-based aerator energy source are as follows.

a) Prepare input water samples (lake water next to the workshop).
b) Put water into a reservoir (dirty water container).
c) Measure the initial pH and TDS values of the sample (before being put into the device), using a pH meter and TDS meter
d) Turn on the pump and UV water sterilizer, so that the water flows from the reservoir and passes through all the filtration processes.
e) Collect 250 ml of output water (the result of the filtration process).
f) Measure the pH and TDS values of the output water (water that comes out of the filtration process) using a PH meter and TDS meter.
g) Record the research results in the table
h) Repeat steps "a" to "g" 30 times.

The data analysis technique in the study entitled the manufacture and performance test of water purifiers with solar panel electrical energy sources is as follows. The research data are pH and TDS values, water measured before and after going through the filtration process. The data collection process was carried out 30 times. The data analysis technique is as follows.

a) Presenting data (pH and TDS values of input and output water) in a table.
b) Calculate the average of pH and TDS of before and after filtration using equation (1) (Montgomery, 2013).

$$\bar{\mu} = \frac{\sum_{i=1}^{30} \mu_i}{30}$$

c) The relative error value was calculated using standard deviations such as equation (2) (Montgomery, 2013).

$$S_\mu = \sqrt{\frac{\sum_{i=1}^{30}(\mu_i - \bar{\mu})}{30 - 1}}$$

d) The t-test was used because it compared the mean between two data groups whose variants were not yet know (Montgomery, 2013). T-test formula in equation (3).

$$t_o = \frac{\mu_1 - \mu_2}{S_p\sqrt{\frac{1}{n_1} - \frac{1}{n_2}}}$$

e) Sp is an estimation of common variance formulated as equation (4), (Montgomery, 2013).

$$S_p = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_1 - 1)S_2^2}{n_1 + n_2 - 2}}$$

f) Reject Ho if $|t_o| > t_{\alpha/2,\vartheta}$ (Montgomery, 2013). The first Ho was there is no difference in the average of pH values between the water that before and after filtration. The second Ho was there is no difference in the average of TDS values between the water before and after filtration.

g) Creating a line graph based on pH data. Data for creating the graph is taken from the pH values of the data group before and the data group after. The graph has two lines of different colour, which represent the pH value profile before and after going through the filtering process.
h) Conducting a descriptive analysis of the pH value profile graph that has been created in step “b”.
i) Creating a line graph based on TDS data. Data for creating the graph is taken from the TDS values before and after going through the filtering process. The graph has two lines of different colour, which represent the TDS value profile of the water data group before and after going through the filtering process.
j) Conducting a descriptive analysis of the TDS value profile graph that has been created in step “d”.

3. Result and Discussion

3.1 Result

This research began with the creation of a water purifier powered by solar panels, as shown in Figure 2. This activity took place from March to June 2024, at the Mechanical Engineering Department Workshop, Politeknik Negeri Sambas.



Figure 2. Water purifier with solar panel electrical energy source

Based on Figure 2, this water purifier has dimensions of length: 76 cm, width: 76 cm, and height: 140 cm. This tool, which is predominantly white and orange, has nine filter tubes consisting of coconut fibbers, sea shells, zeolite sand, silica sand, activated charcoal from coconut shells, activated charcoal from rice husks, microfilters (10 micrometre, 0,5 micrometre and 0,1 micrometre). This tool operates by utilizing electricity from solar panels. When sunlight hits the solar panels, a direct current (DC) is generated. The electric current flows and is stored in the battery (12V 65Ah). The current from the battery is then used to power the DC water pump (12V 50W). In addition, the electric current from the battery is also channelled to the inverter (4000W) to convert the DC input current (12V) to AC output (180 V). This AC current is used to power the UV water sterilizer.

The device works by turning on the pump, causing dirty water to flow into the first tube and filter it using coconut fibbers. This tube filters out solid impurities such as mud. The water then flows into the second tube, which contains seashells. This second tube filters out excess iron in the water, which can cause it to smell and appear oily. After passing through the second tube, the water enters the third tube, which contains zeolite sand. Zeolite sand binds organic matter, increases phosphorus (P) and potassium (K) in the soil, acts as a molecular filter, acts as a cation exchanger, catalysis chemical reactions in the soil, and absorbs metals. The fourth tube is filled with activated coconut charcoal to eliminate unpleasant odours in the water. The fifth tube uses activated charcoal from rice husks to absorb fine particles, odours, and colour in the water. The sixth tube uses beach sand to retain solid particles such as mud, soil, and organic matter dissolved in the water. After passing through these six tubes, the water appears clearer. To improve water purity, the seventh, eighth, and ninth tubes filter the water again using microfilters with increasingly smaller sizes, namely 10 microns, 0.5 microns, and 0.1 microns. This serves to retain dissolved substances still contained in the water (with large sizes) at this stage, so that the resulting water becomes clearer. After passing through the filtering tube, the water is sterilized in a UV sterilizer tube, so that microbes that still escape the physical filtering stage are eliminated by ultraviolet light. Through the outlet of the UV sterilizer tube, the filtered water will flow.

After carrying out the tool testing process, by measuring the pH and TDS values of the water, before and after being filtered using the tool, the research results data are presented in Table 1.

Table 1. Research results data

No of sample	Before			After		
	pH	TDS (ppm)	Color	pH	TDS (ppm)	Color
1	8,3	65	Cloudy	7,0	147	Clear
2	8,1	65	Cloudy	6,9	139	Clear
3	8,2	65	Cloudy	6,9	132	Clear
4	8,2	65	Cloudy	7,0	132	Clear
5	8,2	65	Cloudy	7,1	132	Clear
6	8,2	64	Cloudy	6,9	126	Clear
7	8,0	65	Cloudy	6,8	124	Clear
8	8,1	64	Cloudy	6,7	124	Clear
9	8,1	66	Cloudy	6,8	124	Clear
10	8,1	67	Cloudy	6,7	124	Clear
11	8,1	89	Cloudy	6,7	124	Clear
12	8,2	89	Cloudy	6,7	124	Clear
13	7,8	91	Cloudy	6,7	124	Clear
14	7,9	92	Cloudy	6,7	124	Clear
15	7,6	92	Cloudy	6,8	124	Clear
16	7,8	92	Cloudy	6,7	124	Clear
17	8,0	94	Cloudy	6,7	124	Clear
18	7,9	94	Cloudy	6,7	124	Clear
19	7,9	94	Cloudy	6,7	124	Clear
20	7,9	96	Cloudy	6,7	124	Clear
21	7,9	67	Cloudy	6,9	129	Clear
22	7,9	67	Cloudy	6,9	129	Clear
23	8,0	66	Cloudy	6,8	129	Clear
24	8,0	66	Cloudy	6,8	126	Clear
25	8,0	67	Cloudy	6,8	126	Clear
26	7,7	66	Cloudy	6,8	126	Clear
27	7,7	67	Cloudy	6,8	126	Clear
28	7,7	67	Cloudy	6,8	123	Clear
29	7,7	67	Cloudy	6,8	123	Clear
30	7,8	66	Cloudy	6,8	122	Clear

Based on Table 1 and used the equation (1), (2), (3), (4), the statistical analysis result between the water before and after filtration process was swon by Table 2.

Table 2. The statistical analysis result between the water before and after filtration process

Variable of analysis	pH		TDS	
	Before	After	Before	After
Average: equation (1)	8,0	6,8	74,4	126,8
Standard deviations: equation (2)	0,18	0,11	12,56	5,22
Variants: equation (3)	0,15		9,62	
T-test: equation (4)	116,93		81,27	
T-table (n = 30, α/2 = 0,005)	2,750		2,750	

Based on the statistical analysis result in Table 2, we can conclude the T test as follows:

a. Reject Ho for pH analysis, that mean: there was difference in the average of pH values between the water that before and after filtration.
b. Reject Ho for TDH analysis, that mean: was there was difference in the average of TDS values between the water before and after filtration.

In addition to statistical analysis, qualitative analysis was also conducted. This was done using graphical methods. The pH value change profile is presented in Figure 3.

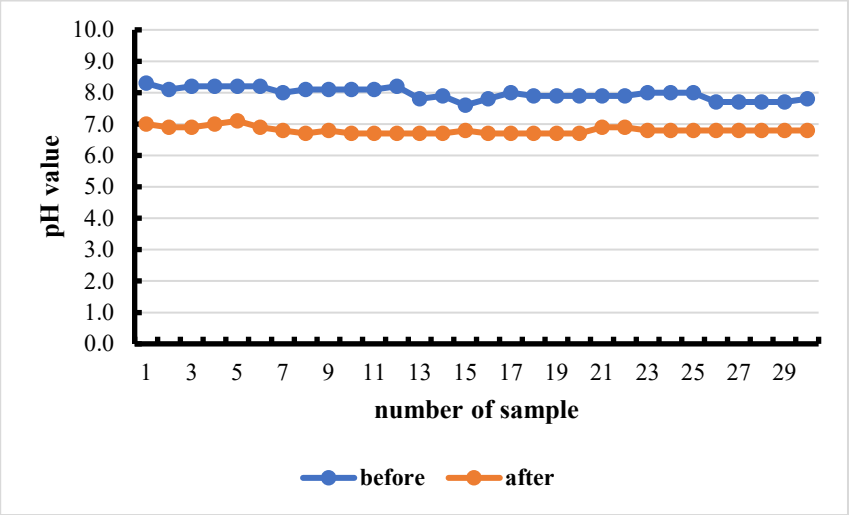


Figure 3. Graph of the profile of changes in water pH value.

Visually, Figure 3 shows that after going through the filtering process, the water's pH was reduced by 1.1. The average pH of the water before entering the filtering process (7.9) was relatively higher than the average pH of the water after going through the filtering process (6.8). The highest pH value in the input water data group (before entering the filtering process) was 8.3 and the lowest pH was 7.6. The highest pH value in the output water data group (after going through the filtering process) was 7.1 and the lowest pH was 6.7.

Based on the measured TDS values before and after the filtration process presented in Table 1, the profile of changes in TDS values is presented in Figure 4.

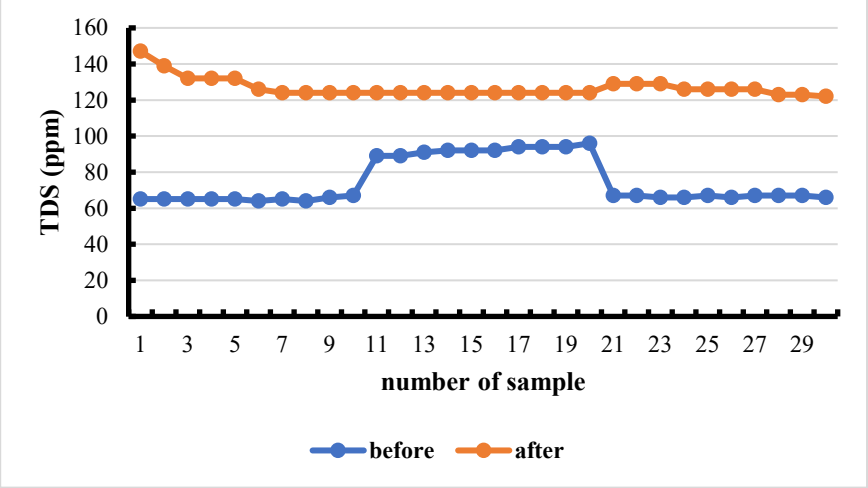


Figure 4. Graph of the profile of changes in water TDS values.

Visually, Figure 4 shows that after going through the filtering process, the water TDS value can be increased by 52 ppm. The average TDS of input water (before filtering) is 74 and the average TDS of output water (after filtering) is 126. The highest TDS value in the input water data group is 96 ppm and the lowest TDS value in the input water data group is 64 ppm. The highest TDS value in the output water data group is 147 ppm and the lowest TDS value in the output water data group is 122 ppm.

3.2 Discussion

Based on the results of the water purifier testing process using solar panels as the power source, which has been carried out 30 times, three facts can be formulated as follows. First, the colour of the water after going through the filtering process is clearer than before. Second, the average pH value of the water after going through the filtering process is 6.8. This value is lower than the average pH value of water before going through the filtering process (7.9). Third, the average TDS value of the water after going through the filtering process is 126 ppm. This value is higher than the average TDS value of water before going through the filtering process (74 ppm).

The factor causing the water colour to become clearer is because this water purifier is equipped with nine tubes equipped with filters including coconut fibber, sea shells, zeolite sand, activated charcoal from coconut shells, activated charcoal from rice husks, beach sand and microfiltration of 10µm, 0.5 µm and 0.1 µm. Zeolite sand can remove mud content in the water. Beach sand can oxidize the iron and manganese content dissolved in the water into other compounds that are insoluble in water, so they can be filtered easily. Charcoal or activated carbon can remove micro-pollutants such as organic matter, bad odor, and color. Microfiltration can retain bacteria and particles measuring 0.1 to 10 µm (Yaqin et al., 2020). Furthermore, the presence of a UV water sterilizer can effectively destroy viruses and bacteria that still pass through the mechanical filtration process. The advantages of a UV water sterilizer are that it is non-toxic and harmless, can destroy organic pollutants, eliminates bad odor and taste in water, requires a short contact time in its use, can kill pathogenic microorganisms, and does not affect minerals in the water (Szolga and Cilean, 2021). It can be concluded that the multi-stage mechanical filtration process combined with an electronic sterilization process (hybrid) can produce output water with a clear colour.

The factor causing the pH value to decrease is the contact that occurs between the water and the filter material contained in the filtration tubes. The longer the contact that occurs during the filtration and adsorption process, the more effective it is in lowering the pH value. The adsorption process using activated charcoal and zeolite media can bind cations in water such as iron (Fe), aluminium, or magnesium. Therefore, the reduction of metal compounds in the water will have an impact on the decrease in the water's pH value. According to Minister of Health Regulation No. 32 of 2017, a safe pH for water for sanitation hygiene is a pH with a value of 6.5-8.5 (Gathun, 2021). In this study, the average pH value of the output water was 6.8. A pH value of 6.8 indicates natural water.

Activated carbon is a factor that causes the TDS value to increase. Ariani et al. (2020) stated that the presence of activated carbon can increase the mineral content in water. This increase in mineral content has an impact on increasing the TDS value. TDS is the number of dissolved solids in water, the TDS value indicates the content of organic and inorganic substances, minerals, and materials dissolved in it. According to the World Health Organization (WHO), the TDS content for drinking water must be above 100 ppm. This is because low TDS

content in drinking water can cause circulatory system disorders because the body lacks necessary minerals (Ariani et al., 2020). According to Minister of Health Regulation No. 31 of 2017, the TDS value of drinking water must be below 1000 ppm. In this study, the average TDS value of water after going through the filtration process was 126 ppm (above 100 ppm and below 1000 ppm), so it has met the requirements of the WHO and Minister of Health Regulation No. 31 of 2017.

4. Summary

Based on the description of the results and discussions that have been carried out, it can be concluded that. (a) A water purifier has been successfully modified with a hybrid system based on solar panels with a length of 180 cm, a width of 40 cm and a height of 100 cm. It has become a water purifier with a solar panel electrical energy source with a length of 76 cm, a width of 76 cm and a height of 140 cm. This tool is equipped with nine filtration tubes containing coconut fibber, sea shells, zeolite sand, activated charcoal from coconut shells, activated charcoal from rice husks, beach sand and microfiltration measuring 10µm, 0.5 µm and 0.1 µm. After going through a mechanical filtration process through nine filter tubes, the water is also electrically sterilized with a UV water sterilizer. The lights on the UV water sterilizer and the water pump are turned on using electricity sourced from solar panels. (b) The results of the performance test of the water purifier with a solar panel electrical energy source show that this tool is able to improve water quality. It is known that the input water has a cloudy colour, an average pH value of 7.9 and an average TDS value of 74 ppm, after passing through this tool it becomes water that has a clear colour, an average pH value of 6.8 (neutral) and an average TDS value of 126 ppm (meeting WHO standards and Minister of Health Regulation No. 31 of 2017).

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Kajian Terhadap Perbandingan Kekuatan Mampatan Bata Tanah Liat Dengan Bata Simen

Nik Saifudin Bin Nik Md Salleh[1*], Jamal Bin Subur[2], Mohd Hanif Bin Abd Rahman[3]

[1,]Civil Engineering Department, Km 08, Jalan Paka, 23000 Kuala Dungun, Terengganu.
[2,3]Civil Engineering Department, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

nik.saifudin@psmza.edu.my[1], jamal@polikk.edu.my[2], hanif@polikk.edu.my[3]

Abstrak

Bata merupakan bahan binaan penting yang digunakan secara meluas dalam pembinaan struktur seperti dinding, tembok dan bangunan. Ia telah digunakan sejak sekian lama dan masih kekal relevan hingga kini. Seiring perkembangan industri pembinaan moden, pelbagai jenis bata telah dihasilkan untuk memenuhi keperluan teknikal dan ekonomi, antaranya bata simen dan bata tanah liat. Kedua-dua jenis bata ini mempunyai kelebihan tersendiri dari segi kekuatan struktur, ketahanan serta kos. Namun, timbul persoalan dalam kalangan pengguna dan kontraktor mengenai tahap kekuatan sebenar antara kedua-dua jenis bata ini kerana maklumat teknikal tidak disertakan semasa pembelian. Justeru, kajian ini dijalankan bagi membandingkan kekuatan mampatan antara bata simen dan bata tanah liat yang digunakan secara meluas dalam industri pembinaan. Sepuluh sampel setiap jenis bata telah diperoleh dari pasaran sekitar Dungun dan diuji menggunakan mesin mampatan konkrit untuk mendapatkan data kekuatan mampatan yang tepat. Hasil ujian menunjukkan bata tanah liat mencatatkan kekuatan mampatan yang lebih tinggi iaitu 25.9 MPa berbanding bata simen yang hanya mencatatkan 7.76 MPa. Analisis ini menunjukkan bata tanah liat lebih sesuai untuk struktur berat seperti dinding luar bangunan, manakala bata simen masih boleh digunakan dalam pembinaan ringan kerana ia melepasi syarat minimum 5.2 MPa mengikut Malaysia Standard MS76 (1972). Selain itu, kajian turut meneliti kadar resapan air kedua-dua bata sebagai panduan tambahan. Secara keseluruhan, kajian ini membantu kontraktor dan pengguna membuat keputusan lebih bijak berdasarkan keperluan struktur dan persekitaran.

Kata Kunci *:Perbandingan, kekuatan, bata tanah liat, bata simen*

1.0 Pengenalan

Bata adalah salah satu bahan binaan terawal yang digunakan oleh manusia dalam pembinaan struktur seperti rumah, tembok, dan bangunan. Sehingga kini, bata terus memainkan peranan penting dalam industri pembinaan kerana sifatnya yang kukuh, tahan lama, dan mudah didapati. Pada abad ke-21, penekanan terhadap kewujudan bata lestari dan mampan meningkat secara ketara. Kajian komprehensif oleh Saravanan & Rao (2023) mengulas kemajuan penggunaan sisa industri dan pertanian seperti abu terbang, sisa bata, abu tebu dan abu daun pisang dalam penghasilan bata untuk mengurangkan penggunaan tenaga, jejak karbon serta meningkatkan prestasi mekanikal dan termal. Kajian ini mencatat penggunaan sisa sebagai bahan stabiliser dalam bata dibakar dan tidak dibakar, dan menegaskan kaedah ini sejajar dengan matlamat ekonomi dan pengurusan sisa Lestari.

Menurut kajian oleh Zhou et al. (2019) menunjukkan bahawa bata tanah liat dihasilkan melalui proses pembakaran pada suhu tinggi, manakala bata simen dihasilkan dengan campuran simen, pasir, dan air yang dikeringkan secara semula jadi atau menggunakan stim Kedua-duanya mempunyai kelebihan tersendiri. Bata tanah liat terkenal dengan ketahanan terhadap cuaca serta kekuatan yang tinggi, manakala bata simen lebih murah dan cepat dihasilkan

Almssad et al. (2022) membincangkan secara menyeluruh bagaimana sistem batu bata menyumbang kepada seni bina lestari melalui kawalan haba pasif, penyerapan tenaga, dan jangka hayat struktur yang panjang. Kajian ini menggariskan bahawa bata bukan sahaja berperanan sebagai elemen struktur, tetapi juga sebagai komponen termal aktif yang dapat menyimpan dan mengatur suhu dalaman bangunan dengan berkesan. Ini dicapai melalui keupayaan bahan bata menyerap haba siang hari dan melepaskannya semula pada waktu malam, fenomena yang dikenali sebagai *thermal lag* atau lengahan haba. Ciri ini menjadikan bata amat sesuai untuk iklim tropika dan separa gersang yang mempunyai perbezaan suhu siang dan malam yang ketara.

Jha dan Kewate (2024) meneliti secara menyeluruh proses fabrikasi eco-brick, iaitu batu bata mampan yang diperbuat daripada bahan buangan atau bahan kitar semula seperti plastik, habuk papan, dan abu industri. Kajian mereka menumpukan kepada inovasi teknologi dalam pembuatan bata mesra alam yang bertujuan mengurangkan pergantungan terhadap simen Portland serta membangunkan kaedah penghasilan bahan binaan berasaskan konsep ekonomi bulatan (*circular economy*).

Tambahan pula, dengan adanya pelbagai pembekal bata di pasaran, termasuk pengusaha kecil yang menghasilkan bata simen secara tempatan, mutu produk sering kali tidak seragam. Hal ini menimbulkan keperluan bagi satu penilaian saintifik yang dapat memberikan gambaran sebenar terhadap prestasi kedua-dua jenis bata dari segi kekuatan mampatan. Kekuatan mampatan adalah salah satu sifat mekanikal terpenting bagi bata, kerana ia memberi gambaran sejauh mana sesuatu bata mampu menanggung beban tegak sebelum mengalami kegagalan (Harun & Ismail, 2015).

Namun begitu, maklumat teknikal mengenai kekuatan sebenar bagi setiap jenis bata jarang disediakan kepada pengguna. Justeru itu, objektif kajian ini dijalankan untuk membandingkan kekuatan mampatan antara bata tanah liat dan bata simen yang terdapat di pasaran tempatan. Oleh itu, kajian ini dijalankan secara sistematik dengan mengumpul sampel bata simen dan bata tanah liat dari pembekal sekitar daerah Dungun, Terengganu sebelum diuji di makmal

menggunakan mesin mampatan. Kajian ini hanya memfokuskan ujian kekuatan mampatan ke atas sampel bata yang berada di pasaran Dungun pada keluaran tahun semasa iaitu tahun 2025 sahaja tanpa menjalankan ujian-ujian yang melibatkan faktor-faktor lain yang mempengaruhi kekuatan mampatan.

Dungun, Terengganu dipilih sebagai lokasi persampelan kerana ia merupakan sebahagian daripada koridor pembangunan industri Pantai Timur yang sedang mengalami pertumbuhan pesat dalam sektor perumahan, pelancongan dan perindustrian. Menurut Rancangan Tempatan Daerah Dungun 2035, daerah ini disasarkan menjadi kawasan berpendapatan tinggi dengan penekanan kepada pembangunan pelancongan dan industri asas tani serta petrokimia. Selain itu, statistik menunjukkan peningkatan populasi dan aktiviti pembinaan yang aktif menjadikan Dungun sebagai lokasi yang relevan untuk menilai prestasi bahan binaan seperti bata dalam konteks pembinaan sebenar.

2.0 Kajian Literatur

Bata merupakan bahan binaan tradisional yang telah digunakan sejak beribu tahun lalu dalam pelbagai jenis struktur, daripada kediaman sederhana hingga ke bangunan monumental. Secara umum, bata boleh dikelaskan kepada dua kategori utama iaitu bata tanah liat dan bata simen. Setiap jenis bata mempunyai ciri mekanikal dan fizikal yang berbeza bergantung kepada bahan asas, kaedah penghasilan dan faktor persekitaran.

Menurut kajian oleh Stępień et al. memfokus kepada perbandingan sifat hygroscopic dan kekuatan mampatan bagi bata seramik *(clay bricks)* daripada pelbagai era. Mereka menemui hubungan berpengaruh antara penyerapan air (capillary rise), kebolehtelapan air dan kekuatan mampatan. Secara keseluruhannya, bata tanah liat sejarah dan moden menunjukkan kekuatan mampatan yang tinggi dan kestabilan yang baik, menjadikannya pilihan bahan yang sangat dipercayai untuk binaan jangka panjang

Sementara itu, Shakir et al. (2019) melaporkan bahawa bata simen lebih mudah dan cepat dihasilkan kerana ia tidak memerlukan proses pembakaran. Bata simen diperbuat daripada campuran simen Portland, pasir, batu halus dan air. Kekuatan mampatan bata simen bergantung kepada nisbah campuran, kadar air dan tempoh pengawetan. Secara purata, kekuatan mampatan bata simen berada dalam lingkungan 7 hingga 10 MPa selepas 28 hari pengawetan.

Kajian oleh Sani, Hamid dan Aziz (2021) yang dilakukan di Malaysia mendapati bahawa kekuatan mampatan bata simen tempatan berbeza mengikut lokasi kilang dan kaedah pembuatan. Mereka melaporkan bahawa sesetengah bata simen yang dijual di pasaran tidak mencapai kekuatan minimum yang disarankan oleh Malaysia Standard (MS) 76:1972, iaitu 5.2 MPa. Sebaliknya, kajian oleh Rahmat dan Zulkifli (2020) menunjukkan bahawa bata tanah liat yang dihasilkan secara tradisional mampu mencapai kekuatan mampatan melebihi 20 MPa apabila dibakar secara konsisten pada suhu tinggi.

Selain kekuatan mampatan, kadar serapan air juga memainkan peranan penting dalam menentukan ketahanan bata terhadap cuaca lembap dan pertumbuhan kulat. Bata tanah liat cenderung menyerap lebih banyak air berbanding bata simen, namun beberapa kajian mencadangkan bahawa pengubahsuaian komposisi atau penambahan bahan tambah boleh

meningkatkan ketahanannya. Namun begitu, kajian ini hanya memfokuskan kepada ujian kekuatan mampatan tanpa mengambilkira ujian-ujian bagi faktor-faktor lain yang mempengaruhi kekuatan mampatan bata.

Kesemua kajian ini menunjukkan bahawa kedua-dua jenis bata mempunyai potensi fungsi tersendiri bergantung kepada keperluan struktur, kos dan persekitaran. Oleh itu, adalah penting untuk menjalankan penilaian menyeluruh terhadap prestasi sebenar bata yang digunakan dalam industri pembinaan tempatan bagi memastikan keselamatan dan ketahanan struktur bangunan.

3.0 Metodologi Kajian

3.1 Reka Bentuk Kajian

Kajian ini dijalankan dalam bentuk eksperimen makmal untuk menilai dan membandingkan kekuatan mampatan dua jenis bata, iaitu bata tanah liat dan bata simen. Pendekatan kuantitatif digunakan dengan ujian mekanikal yang dijalankan ke atas spesimen bata menggunakan mesin mampatan konkrit. Semua ujian dilakukan mengikut garis panduan dalam Malaysia Standard 76:1972 dan British Standard 3921, untuk memastikan ketepatan dan kebolehpercayaan keputusan yang diperoleh. Rekabentuk kajian ini bertujuan untuk memberikan pemahaman yang lebih mendalam mengenai prestasi kedua-dua jenis bata dalam keadaan yang terkawal. Kekuatan mampatan adalah salah satu aspek penting dalam penilaian ketahanan bahan binaan, yang mana ia memberi kesan langsung terhadap daya tahan bata dalam pelbagai keadaan pembinaan. Dengan menggunakan ujian yang sesuai dan piawaian yang diiktiraf, kajian ini akan memberikan perbandingan objektif antara kedua jenis bata tersebut, serta memberikan maklumat yang berguna dalam pemilihan bahan yang sesuai mengikut fungsi tertentu dalam pembinaan.

3.2 Persampelan dan Bahan

Setiap sampel dipilih dengan berhati-hati bagi memastikan keadaan sampel yang digunakan adalah dalam keadaan baik, bersaiz standard, dan bebas daripada sebarang keretakan atau kecacatan yang ketara. Pemilihan sampel yang tepat adalah penting dalam memastikan ketepatan keputusan kajian dan membolehkan perbandingan yang adil antara kedua jenis bata. Kajian ini memastikan bahawa sampel yang digunakan dalam eksperimen adalah representatif dan boleh dipercayai, serta tidak mengganggu ketepatan keputusan yang diperoleh dalam kajian ini. Selain itu, semua sampel diuji dengan kaedah yang sama bagi mengelakkan bias dalam keputusan dan hasil yang lebih sahih.



Rajah 1. Sampel bata tanah liat yang diambil dari kedai

3.3 Prosedur Ujian Mampatan

Ujian mampatan dilaksanakan menggunakan mesin ujian mampatan hidraulik berkapasiti 2000 kN, yang mampu memberikan beban secara berterusan kepada sampel bata sehingga berlaku kegagalan. Setiap sampel bata diuji secara mendatar dengan memastikan beban dikenakan secara seragam ke atas permukaan bata. Prosedur pengujian ini mematuhi garis panduan yang terdapat dalam MS 76:1972 dan BS 3921, yang merupakan piawaian yang diterima secara meluas dalam ujian mampatan bahan binaan. Mesin mampatan ini memberikan tekanan yang konsisten dan tepat, memastikan bahawa hasil ujian adalah sahih dan boleh dipercayai. Keputusan yang diperoleh daripada ujian mampatan ini memberikan maklumat tentang daya tahan bata terhadap tekanan dan boleh digunakan untuk menentukan ketahanan bata dalam pelbagai jenis pembinaan.



Rajah 2. Mesin mampatan konkrit di Makmal Konkrit

3.4 Kaedah Analisis Data

Data yang diperoleh daripada ujian mampatan akan dianalisis menggunakan kaedah statistik deskriptif. Statistik seperti purata, sisihan piawai, dan perbandingan hasil ujian akan digunakan untuk menilai perbezaan kekuatan mampatan antara bata tanah liat dan bata simen. Selain itu, keputusan ujian akan dibandingkan dengan syarat minimum kekuatan mampatan yang ditetapkan dalam standard Malaysia dan British, untuk menentukan tahap pematuhan setiap jenis bata terhadap piawaian industri. Dengan analisis ini, keputusan kajian akan

memberikan gambaran jelas tentang kesesuaian penggunaan bata dalam pelbagai struktur pembinaan seperti Jadual 1. Data yang dianalisis juga akan digunakan untuk menentukan jenis bata yang lebih sesuai digunakan berdasarkan kekuatan mampatan yang diuji serta menilai ketahanan bahan tersebut dalam jangka panjang.

Jadual 1. Kekuatan mampatan bata mengikut fungsi

Kategori	Julat Kekuatan Mampatan (MPa)	Fungsi/Aplikasi
Kuat Tinggi	≥ 20.5 Mpa	Struktur galas beban berat, dinding luar bangunan tinggi
Sederhana	10.5 – 20.4 Mpa	Dinding galas beban sederhana, rumah 1–2 tingkat
Rendah	7.0 – 10.4 Mpa	Dinding bukan galas beban, partisyen dalaman
Di bawah standard	< 7.0 Mpa	Tidak sesuai untuk struktur, perlu pengujian lanjut

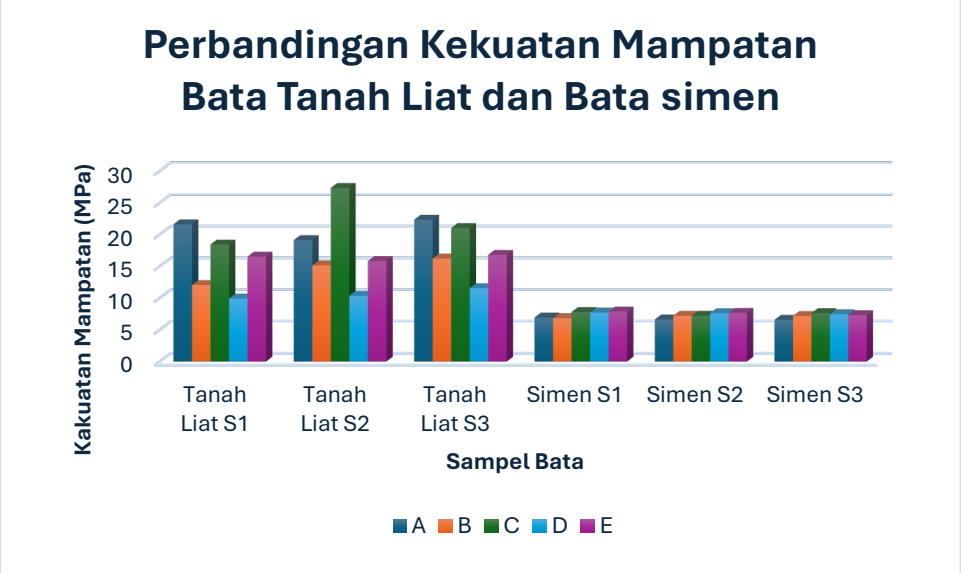
4.0 Analisis Data

Ujian kekuatan mampatan telah dilakukan di Makmal Konkrit, Politeknik Sultan Mizan Zainal Abidin, Dungun, Terengganu. Sebanyak 30 sampel bata telah dikumpul secara rawak dari kedai-kedai di sekitar Dungun, Terengganu. Sampel-sampel ini terdiri daripada dua jenis bata, iaitu 15 bata tanah liat dan 15 bata simen. Hasil ujian kekuatan mampatan ke atas bata simen dan bata tanah liat ditunjukkan di dalam Jadual 2.

Jadual 2. Perbandingan Kekuatan Mampatan Bata Simen dan Bata Tanah Liat mengikut Kedai

Kedai	Kekuatan Mampatan Bata Tanah Liat			Kekuatan Mampatan Bata Simen		
	Sampel 1	Sampel 2	Sampel 3	Sampel 1	Sampel 2	Sampel 3
A	21.61	19.13	22.34	6.93	6.63	6.57
B	12.05	15.14	16.22	6.83	7.21	7.18
C	18.43	27.35	21.04	7.80	7.21	7.63
D	9.92	10.35	11.56	7.72	7.62	7.44
E	16.52	15.84	16.80	7.88	7.66	7.31

Berdasarkan Rajah 3, perbandingan antara kekuatan mampatan bata simen dan bata tanah liat menunjukkan perbezaan yang ketara dalam prestasi kekuatan kedua-dua jenis bahan ini. Kekuatan mampatan purata bata simen di semua kedai berada dalam julat 6.7 hingga 7.3 MPa, manakala bata tanah liat mencapai nilai purata yang lebih tinggi, antara 10.6 hingga 22.3 MPa. Ini menunjukkan bahawa bata tanah liat jauh lebih kuat dalam menahan tekanan berbanding bata simen.



Rajah 3.Perbandingan Kekuatan Mampatan Bata Tanah Liat dan Bata simen

Jadual 3 .Perbandingan Purata Kekuatan Mampatan Bata Simen dan Bata Tanah Liat mengikut Kedai

Kedai	Kekuatan Mampatan Bata Tanah Liat		Kekuatan Mampatan Bata Simen	
	Minimun (Mpa)	Purata	Minimun (Mpa)	Purata
A	7.00	21.03	7.00	6.63
B		14.47		7.21
C		22.27		7.21

Namun, penting untuk diingat bahawa nilai kekuatan mampatan minimum untuk bata simen adalah sekitar 7.0 MPa, yang mana merupakan had minimum yang diterima untuk kebanyakan aplikasi pembinaan. Merujuk Jadual 3, ada kedai yang mencatatkan nilai purata yang sedikit lebih rendah daripada 7.0 MPa seperti Kedai A dengan nilai 6.63 MPa. Namun bagi bata tanah liat semua kedai menunjukkan prestasi yang lebih konsisten dengan kekuatan mampatan yang jauh melebihi 7.0 MPa, menjadikannya lebih sesuai untuk fungsi struktur yang memerlukan ketahanan tinggi.

Jadual 4. Ujian-T Bebas dan Sisihan Piawai Bagi Bata Simen dan Bata Tanah Liat

Jenis Bata	Sisihan Piawai (MPa)	Ujian-T
Tanah Liat	4.92	T-statistik : 6.0736
Simen	0.35	P_nilai :00000

Merujuk kepada Jadual 4 menunjukkan data sisihan piawai bagi bata tanah liat ialah 4.92 MPa manakala bagi bata simen adalah 0.35 Mpa. Ini menunjukkan bahawa bata tanah liat mempunyai variasi kekuatan yang lebih besar antara sampel berbanding bata simen, yang lebih konsisten tetapi pada tahap kekuatan yang lebih rendah. Bagi Ujian-T Bebas, menunjukkan

bahawa perbezaan kekuatan mampatan antara bata tanah liat dan bata simen adalah signifikan secara statistik ($p < 0.05$). Ini menunjukkan bahawa bata tanah liat mempunyai kekuatan yang lebih tinggi secara konsisten berbanding bata simen, dan perbezaan ini bukan disebabkan oleh kebetulan atau variasi rawak.

Perbezaan besar dalam kekuatan mampatan ini juga memberi impak kepada pilihan penggunaan kedua-dua jenis bata. Bata tanah liat lebih sesuai untuk bangunan atau struktur yang memerlukan ketahanan terhadap tekanan yang lebih besar, manakala bata simen lebih fleksibel dalam aplikasi umum dengan kos yang mungkin lebih rendah dan penghasilan yang lebih mudah. Faktor kos dan kemudahan pembinaan tetap menjadi pertimbangan penting apabila memilih jenis bata yang tepat. Oleh itu, pemilihan bahan ini harus mengambil kira keperluan teknikal serta faktor ekonomi dalam sesebuah projek pembinaan.

Peningkatan kekuatan mampatan pada bata tanah liat dapat dikaitkan dengan proses pembuatan yang lebih memerlukan suhu pembakaran yang lebih tinggi dan bahan mentah yang lebih tahan lama. Bata tanah liat juga lebih tahan terhadap cuaca ekstrem dan mempunyai daya tahan yang lebih baik terhadap kerosakan fizikal seperti retak atau hancur di bawah tekanan tinggi.

5.0 Kesimpulan

Berdasarkan ujian kekuatan mampatan ke atas 30 sampel bata dari lima kedai di Dungun, Terengganu, didapati bahawa bata tanah liat menunjukkan kekuatan mampatan yang jauh lebih tinggi berbanding bata simen. Purata kekuatan bata tanah liat berada dalam julat 14.47 hingga 22.27 MPa, manakala bata simen hanya mencapai 6.63 hingga 7.21 MPa. Ujian-t bebas menunjukkan perbezaan ini adalah signifikan secara statistik ($p < 0.001$),

Walau bagaimanapun, kajian ini terhad kepada sampel dari kawasan geografi tertentu dan tidak mengambil kira faktor seperti kos, kemudahan pemasangan, dan ketahanan jangka panjang. Oleh itu, kajian lanjutan disarankan untuk menilai prestasi bata dalam keadaan persekitaran sebenar serta analisis kos-manfaat bagi aplikasi pembinaan yang berbeza. Secara keseluruhan, dapatan ini menyokong penggunaan bata tanah liat dalam struktur yang memerlukan ketahanan tinggi, manakala bata simen boleh dipertimbangkan untuk aplikasi bukan struktur atau kos rendah.

Dari sudut kejuruteraan, pemilihan antara bata simen dan bata tanah liat bukan sahaja bergantung kepada kekuatan mampatan, tetapi juga kepada kos pengeluaran, pemasangan, dan prestasi jangka panjang. Perbandingan ini penting untuk memastikan keputusan pembinaan adalah berkesan dari segi teknikal dan ekonomi.

Bata simen lebih murah untuk dihasilkan secara tempatan kerana bahan mentah seperti simen, pasir, dan batu mudah diperoleh dan boleh dikitar semula. Proses penghasilannya juga tidak memerlukan pembakaran suhu tinggi, menjadikannya lebih menjimatkan dari segi tenaga dan masa. Sebaliknya, bata tanah liat memerlukan pembakaran pada suhu tinggi, yang meningkatkan kos tenaga dan pengeluaran. Selain itu, bahan mentah tanah liat perlu diproses

dan dikawal dengan teliti untuk memastikan kualiti yang konsisten. Bata tanah liat juga lebih berat, menyebabkan kos pengangkutan dan pemasangan menjadi lebih tinggi berbanding bata simen.

Walaupun bata tanah liat lebih mahal dari segi pengeluaran dan pemasangan, ia menawarkan kelebihan dari segi ketahanan dan prestasi jangka panjang. Bata tanah liat mempunyai daya tahan yang lebih tinggi terhadap cuaca tropika lembap Malaysia, kurang menyerap air, dan lebih tahan terhadap kerosakan fizikal. Ini bermakna ia memerlukan penyelenggaraan yang lebih rendah dan mengurangkan risiko kerosakan struktur, sekali gus menjimatkan kos pembaikan dalam jangka masa panjang. Sebaliknya, bata simen lebih mudah terjejas oleh kelembapan dan perubahan suhu, yang boleh menyebabkan retakan dan kemerosotan prestasi dari semasa ke semasa.

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Pembangunan Alat Bantuan Mengajar (ABM) Untuk Pemantapan Kemahiran Motor Bagi Orang Kelainan Upaya (OKU)

Sharifah Aznee Binti Said Ali @ Syed Ali[1]*, Mohd Baharuddin bin Mohd Yusoff[2], Muhammad Amir Firdaus Bin Mohd Yuslin[3]

[1,2]Jabatan Kejuruteraan Mekanikal, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park,Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah, Malaysia.

[3]Jabatan Kejuruteraan Mekanikal, Politeknik Port Dickson, KM 14 Jalan Pantai, 71050 SiRusa, Port Dickson, Negeri Sembilan, Malaysia

*aznee@polikk.edu.my

Abstrak

Orang Kelainan Upaya (OKU) merupakan individu yang dikategorikan sebagai individu yang mempunyai kecacatan fizikal, pendengaran, penglihatan, pertuturan, pembelajaran, mental, dan autisme. Individu OKU ini dianggap kurang produktif kerana masalah pergerakkan dan tindak balas yang lambat menyebabkan mereka mengambil masa yang lama untuk memahami sesuatu perkara. Kekurangan fasiliti yang sesuai dengan keupayaan OKU turut menyumbang serta membantutkan proses perkembangan golongan OKU serta membatas penyertaan mereka secara aktif dalam masyarakat. Alat Bantu Mengajar (ABM) yang interaktif dan mampu meningkatkan kemahiran Pengurusan diri di kalangan pelatih OKU amat terhad dan kos yang agak mahal. Keperluan terhadap fasiliti yang mampu menyampaikan kemahiran pengurusan diri dengan lebih berkesan telah menjadi pencetus utama pembinaan ABM, *Independent Shoe Rack Kit* (ISRK). Tujuan utama kajian adalah untuk membangunkan ISRK bagi mempertingkatkan kemahiran motor halus pelatih OKU melalui pendekatan pembelajaran berasaskan aktiviti praktikal. Kajian ini dijalankan secara temubual, pemantauan dan ujikaji bersama tenaga pengajar dan 4 pelatih di Pusat Pemulihan Dalam Komuniti (PPDK) Teluk Kemang, Port Dickson. Hasil daripada ujian menunjukkan bahawa penggunaan ABM ISRK mampu meningkatkan kemahiran motor pelatih OKU termasuk yang mengalami kesukaran pembelajaran seperti *Learning Difficulty (LD)*, *Down Syndrome*, dan *Autisme*. Projek ini menyumbang kepada pembangunan ISRK yang praktikal dan bersesuaian dengan keperluan pelatih OKU di PDK. ISRK ini bukan sahaja memberi pilihan sebagai tambahan fasiliti sedia ada, malah membuktikan mampu digunakan sebagai ABM dalam membantu pembangunan kemahiran motor halus secara sistematik dan menyeronokkan. Kajian ini turut menyumbang kepada bidang pendidikan khas dengan menyediakan model produk yang berpotensi dikembangkan di institusi PDK lain secara lebih meluas.

***Kata kunci**: Alat Bantuan Mengajar; Orang Kelainan Upaya; Pemulihan Dalam Komuniti; Kesukaran pembelajaran; Kemahiran motor*

1. Pengenalan

Orang Kurang Upaya (OKU) adalah merupakan individu yang mempunyai kelainan upaya dari segi fizikal, mental, intelektual atau deria yang menghadkan aktiviti secara penuh dan efektif secara individu mahupun bermasyarakat. Kategori OKU merangkumi pelbagai jenis kelainan seperti masalah penglihatan, pendengaran, pertuturan, pembelajaran, autisme, cerebral palsy dan kecacatan fizikal. Di Malaysia, golongan OKU dilindungi di bawah Akta Orang Kurang Upaya 2008 dan diberikan hak terhadap pendidikan, pekerjaan, kesihatan serta penyertaan sosial. Ini penting bagi menjaga keperluan dan kebajikan OKU yang semakin meningkat selaras dengan perkembangan dasar inklusif negara. Pelbagai usaha dijalankan agar membolehkan OKU menjalani kehidupan yang lebih berdikari dan bermakna, termasuk melalui penyediaan perkhidmatan pemulihan, pendidikan khas, dan bantuan teknologi sokongan. Usaha seperti ini penting untuk membina masyarakat yang prihatin dan inklusif, serta memastikan tiada golongan yang terpinggir dalam arus pembangunan negara.

Menurut statistik Jabatan Kebajikan Masyarakat (JKM) 2023 dan Jabatan Perangkaan Malaysia (DOSM, 2023), seramai 736,607 orang OKU berdaftar, 2.2% daripada jumlah penduduk Malaysia (JKM, 2023). Kategori ketidakupayaan yang paling ramai direkodkan

adalah masalah pembelajaran sebanyak 265,503 orang, diikuti oleh kecacatan fizikal, penglihatan dan pertuturan (JKM, 2023). Merujuk kepada Pertubuhan Kesihatan Sedunia (WHO) sekitar 16% populasi dunia hidup dengan pelbagai bentuk ketidakupayaan (WHO, 2021). Ini menunjukkan keperluan untuk meningkatkan kesedaran masyarakat serta menambah baik sistem sokongan, infrastruktur, dan perkhidmatan yang mesra OKU di Malaysia. Penekanan terhadap penglibatan komuniti dan pembangunan berasaskan masyarakat seperti Program Pemulihan Dalam Komuniti (PDK) adalah antara langkah penting ke arah pembentukan masyarakat inklusif dan prihatin.

PDK dilaksanakan di Malaysia kerjasama dengan Jabatan Kebajikan Masyarakat (JKM) dan Kementerian Kesihatan Malaysia (KKM). Sehingga kini terdapat 562 Pusat PDK di seluruh negara usaha bersepadu antara OKU, keluarga, komuniti serta pelbagai sektor seperti kesihatan, pendidikan dan sosial untuk menyediakan pemulihan, latihan, pendidikan serta integrasi sosial kepada golongan OKU. Penubuhan PDK adalah memupuk keprihatinan dan tanggungjawab komuniti dalam membangunkan potensi OKU dengan penggunaan sumber tempatan yang efisien dan berdaya tahan. PDK Teluk Kemang merupakan salah satu pusat yang aktif menjalankan pelbagai aktiviti rehabilitasi termasuk kemahiran motor, pengurusan diri, perkembangan sosial dan latihan vokasional. Merujuk kepada Hisham, H. H., et al. (2021) kemahiran motor kasar melibatkan kekuatan dan pergerakan otot-otot anggota badan yang besar seperti berlari, melompat, membaling, berjalan dan sebagainya. Manakala motor halus melibatkan kekuatan dan pergerakkan otot yang kecil seperti menulis, memicit memegang, meenggenggam, penggunaan butang dan sebagainya. Seramai 22 OKU yang berusia 8 – 33 tahun dikenali sebagai pelatih yang mengalami masalah pembelajaran seperti *Learning Disabilities* (LD), *Down Syndrom, Attention-deficit/hyperactivity disorder* (ADHD), Autisme dan Cerebral Palsy. Rajah 1 menunjukkan rak kasut sedia ada di PDK. Rak kasut ini merupakan satu peralatan yang digunakan sebagai peralatan asas pengurusan diri yang pertama bagi kanak-kanak OKU di PDK Teluk Kemang. Pelatih perlu menyusun kasut mereka sebaik sampai di PDK. Kebiasaanya pelatih tidak mampu menyusun kasut mereka dengan sempurna dan bersepah sehingga terpaksa kasut disusun oleh guru mereka. Atas sebab itu, rak ini akan ditambahbaik sebagai Alat Bantu Mengajar (ABM) bagi menghasilkan *Independent Shoe Rack Kit* (ISRK) yang mempunyai ciri rekaan dan fungsi yang lebih menarik dan mampu menjana minat pelatih ke arah perkembangan diri dalam pengurusan diri dan mengasah kemahiran motor halus para pelatih. Kekangan dari segi teknologi dan fasiliti yang sesuai bagi keupayaan pelatih ini membataskan peluang pelatih untuk mengembangkan bakat dan potensi secara interaktif dan efisien khasnya dalam meningkatkan kemahiran pengurusan diri. Oleh itu, melalui penyelidikan yang dijalankan bersama pelajar Kejuruteraan Mekanikal, untuk menghasilkan inovasi dalam ABM iaitu ISRK. Tujuan kajian adalah merekabentuk ISRK sebagai ABM berasaskan rak kasut dan menambahbaik ISRK dengan ciri mekanikal bagi meningkatkan kemahiran motor halus melalui ABM dalam proses pembelajaran pelatih.



Rajah 1. Rak Kasut sedia ada

2. Kajian Literasi

Dua perkara utama yang difokuskan dalam kajian lepas iaitu rekabentuk rak kasut sedia ada di pasaran dan aplikasi yang sesuai dengan kemahiran motor.

2.1 Rekabentuk

Dalam reka bentuk rak kasut, faktor ergonomik perlu diambil kira berdasarkan keperluan sasaran pengguna khasnya mengikut ketinggian dan postur badan (Osman Zahid & Abd Aziz, 2023). Hamil and Romli (2024) dalam reka bentuk pembangunan produk haruslah berdasarkan dimensi antropometrik untuk postur duduk dan berdiri untuk penduduk Malaysia untuk meningkatkan keselesaan, produktiviti kerja dan prestasi.

Menurut Ghazali et al. (2021), kriteria khas, selesa harus ada dalam keperluan rekabentuk golongan OKU. Golongan OKU yang mengalami kesukaran dan kecerdasan yang rendah perlu dibantu dengan persekitaran dan kaedah pembelajaran yang interaktif dan menarik dengan pemilihan warna dan bentuk dan saiz peralatan yang sesuai dengan keadaan mereka (Korikana, 2020).

2.2 Kemahiran Motor

Kemahiran motor kasar dan motor halus adalah komponen utama dalam perkembangan fizikal kanak-kanak, termasuk OKU. Kemahiran motor kasar adalah keupayaan mengawal pergerakan otot besar seperti tangan, kaki dan seluruh badan untuk melakukan aktiviti seperti berjalan, melompat, dan berlari. Manakala, kemahiran motor halus pula melibatkan otot-otot kecil seperti jari dan pergelangan tangan yang diperlukan untuk melakukan aktiviti seperti menulis, memegang objek kecil, dan mengikat tali kasut Mulligan (2025). Bagi kategori OKU, gangguan perkembangan kemahiran motor ini memerlukan latihan khusus serta intervensi awal. Rajah 2 menunjukkan *Motor skill training board* (Masterkidz, 2022) yang digunakan dalam mengasah perkembangan kemahiran motor halus.



Rajah 2. *Motor Skill Training Board* (Masterkidz, 2022)

Merujuk Dalakçi, Özüdoğru, & Kararti, (2024) aktiviti berbentuk permainan, sukan ringan, dan latihan sensori dapat membantu merangsang perkembangan motor secara efektif dalam kalangan OKU. Terdapat 2 tahap untuk mengasah perkembangan motor seperti Jadual 1. Aktiviti secara bertahap berguna untuk menyediakan latihan vokasional dan berdikari, serta mendorong mereka mengaplikasikan kemahiran dalam persekitaran sebenar (Ayupe et al., 2024). Merekabentuk *motor skill training tools* dengan kesukaran yang berbeza adalah sangat

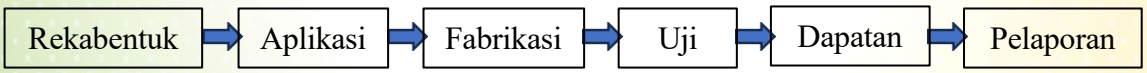
penting bagi setiap pengguna kerana setiap pengguna mempunyai keupayaan pembelajaran yang berbeza (Turakhia et al., 2021).

Jadual 1. Tahap bagi Perkembangan Motor

	Tahap 1	Tahap 2
Maksud	Asas iaitu Aktiviti Pengenalan dan Koordinasi Asas	Lanjutan kepada Latihan Fungsional dan Kemandirian
Penerangan	Aktiviti tahap ini direka bentuk bagi pelatih OKU yang masih dalam peringkat awal menguasai kawalan otot halus dan kasar.	Untuk pelatih yang telah menunjukkan kawalan otot yang lebih baik dan bersedia untuk cabaran motor yang lebih kompleks
Aktiviti	Melatih kemahiran mencengkam dan menyelaraskan mata-tangan. – Fokus pada jari telunjuk dan ibu jari (*pincer grasp*).	Menggabungkan elemen kognitif dan motor untuk menyelesaikan masalah harian.

3.0 Metodologi

Kajian ini dilaksanakan di PDK, Telok Kemang Port Dickson melibatkan 4 orang pelatih yang berusia 12 tahun hingga 30 tahun yang mempunyai masalah pembelajaran, *Learning Disabilities* (LD), *Down Syndrom* dan *Attention-deficit/hyperactivity disorder* (ADHD). Projek rekabentuk dibangunkan dengan menggunakan *Autodesk Inventor Professional 2019*. Rajah 3 menunjukkan carta proses pembangunan ABM ISRK yang dimulai dengan kajian berkenaan rekabentuk yang sedia ada dengan menggunakan kaedah *house of quality* (Xie, Qin, & Jiang, 2020) dan bersesuaian dengan keperluan pelatih OKU dengan mengutamakan pemilihan warna, bentuk dan saiz yang sesuai dengan pelatih. Seterusnya rekabentuk ABM ISRK ini ditambahbaik dengan ciri mekanikal yang sesuai bagi mengasah kemahiran motor halus pelatih OKU. Kemudian setelah selesai, fabrikasi dilaksanakan berdasarkan rekabentuk dan aplikasi yang telah dipilih. Proses ujian dilaksanakan dan turut melibatkan beberapa pihak seperti mendapatkan pandangan dari yang pakar dari kalangan warga pendidik universiti awam dan juga organisasi Persatuan Teknologi Malaysia (TAM). Dapatan di kumpulkan dalam pelaporan dilaksanakan bagi membuat rumusan setelah siap projek ABM ISRK dilaksanakan.



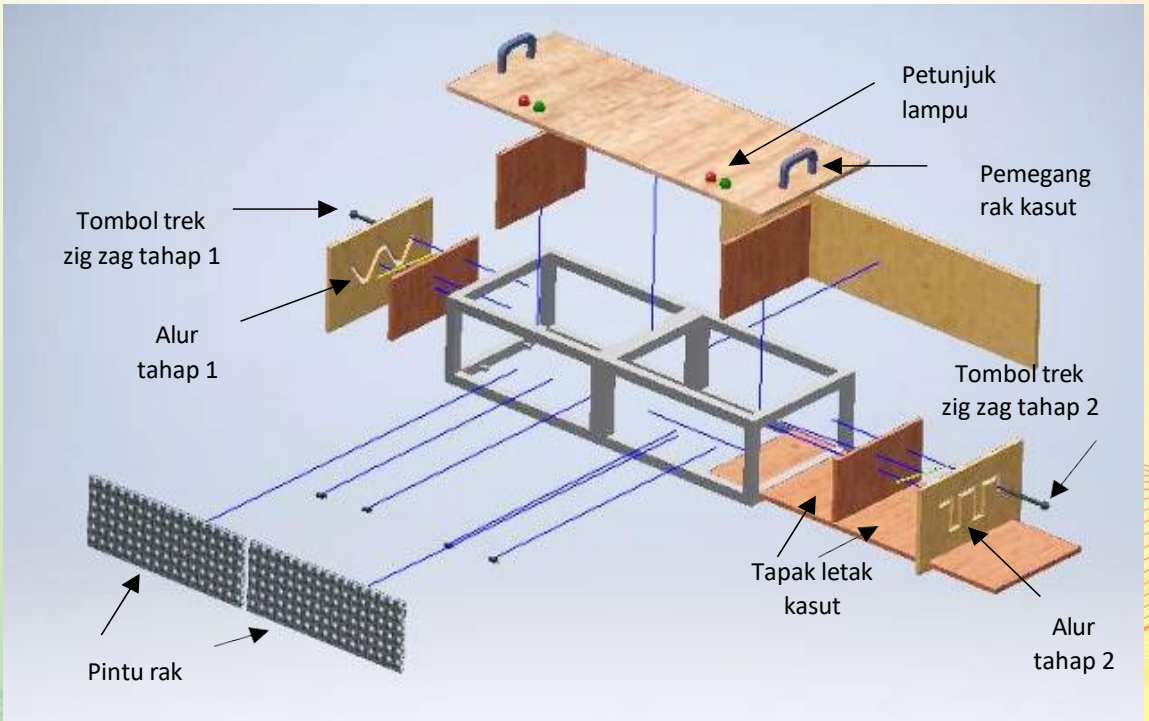
Rajah 3. Carta Proses Pembangunan ABM ISRK

4.0 Dapatan Dan Perbincangan

Rajah 4 menunjukkan Lukisan 3D pemasangan ISRK yang direka khas sebagai ABM untuk melatih kemahiran kendiri (*self-care*) dan kemahiran motor halus dalam kalangan kanak-kanak OKU. Reka bentuk ini menekankan aspek interaktif dan modular yang sesuai untuk penggunaan di pusat pemulihan komuniti (PDK), bilik terapi, atau rumah. Rekabentuk ABM ISRK ini membantu kanak-kanak OKU di PDK dalam pengurusan diri kehidupan seharian mereka bagi menyimpan dan menyusun kasut secara tersusun dan kendiri. Mereka memerlukan Kemahiran motor halus dan kasar dalam melaksnakan tugasan ini seperti memusing, menggenggam dan tekan. Komponen utama ABM ISRK ini adalah seperti

berikut:

1. Rangka Logam
    - Struktur sokongan utama bersaiz 90cm x 35 cm x 20cm supaya stabil dan mudah diakses dari kedua-dua sisi oleh kanak-kanak di PDK.
2. Permukaan Atas Kayu + Pemegang (Atas)
    - Dilengkapi dengan dua pemegang yang boleh digunakan sebagai alat bantuan genggaman.
    - Terdapat dua butang berwarna (merah dan hijau), berfungsi sebagai elemen interaktif (latihan tekan tekan), Simulasi isyarat mula dan tamat latihan, dan latihan warna dan kognitif.
3. Panel Aktiviti Sisi (Kiri dan Kanan)
    - Panel kiri menunjukkan elemen seperti spring atau zig-zag *track* – boleh digunakan untuk melatih koordinasi tangan dan mata serta kemahiran manipulasi.
    - Panel kanan mungkin terdiri daripada track laluan atau slot – sesuai untuk aktiviti masukkan kasut ke rak, atau latihan menyusun.
4. Panel Rak Kasut (Kanan Bawah)
    - Ruang khas untuk meletak kasut atau mensimulasikan aktiviti menyimpan objek.
        - Dapat melatih pengguna menyusun mengikut saiz, bentuk atau warna.



Rajah 4. Lukisan Pemasangan ABM ISRK

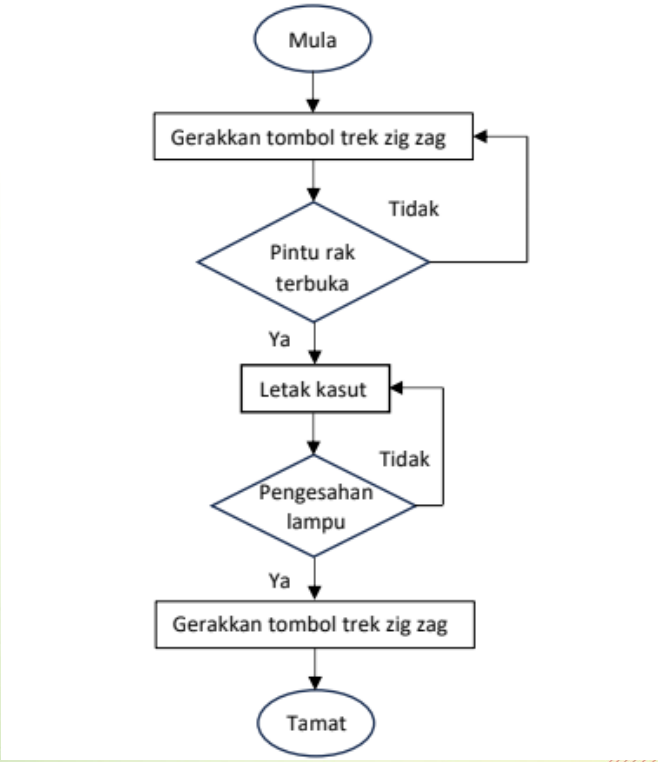
Rajah 5 menunjukkan alat ABM ISRK yang sebenar. Rajah 5(a) adalah pandangan bahagian kiri mewakili tahap 1 Rajah 5(b) adalah pandangan bahagian kanan mewakili tahap 2.



(a) **(b)**

Rajah 5. Produk ABM ISRK

Rajah 6 menunjukkan prosedur penggunaan alat ABM ISRK ini. Langkah ini boleh diguna pakai bagi ke Tahap 1 dan Tahap 2. Pelatih perlu gerakkan tombol trek zig zag ikut alur papan sehingga ke hujung. Pintu rak akan terbuka secara automatik setelah sampai di bahagian hujung zig zag seperti di Rajah 7. Kasut diletakkan mengikut tapak yang disediakan. Sebagai pengesahan kedudukan kasut dipaparkan melalui petunjuk lampu berwarna merah bernyala (jika posisi kasut salah) Rajah 7(a) manakala petunjuk lampu hijau akan bernyala (jika posisi kasut betul) Rajah 6(b). Tombol trek zig zag perlu ditutup kembali bagi penutup pintu rak. Langkah ini diulangi langkah ini bagi alur Tahap 2.



Rajah 6. Langkah pengunaan ABM ISRK

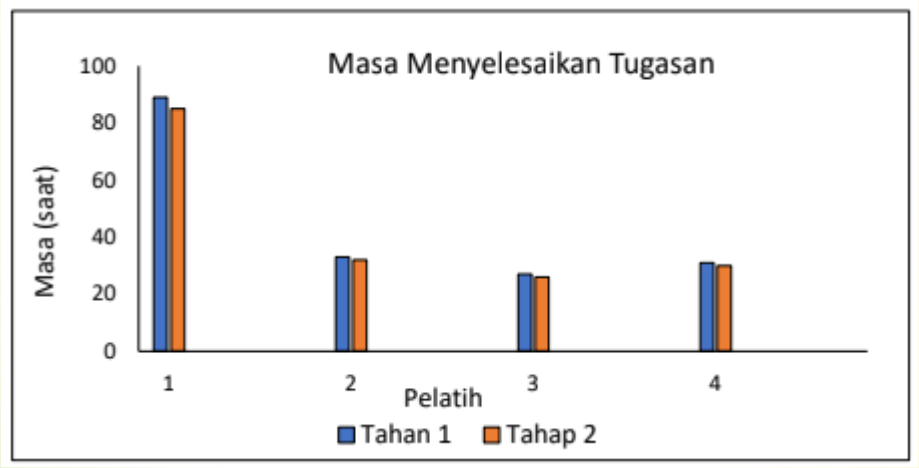




(a) **(b)**

Rajah 7: Petunjuk lampu kedudukan kasut

Rajah 8 menunjukkan Masa yang diperuntukkan untuk menyelesaikan tugasan ABM ISRK dikalangan Pelatih yang terlibat dari kanak-kanak OKU PDK. Secara keseluruhan Pelatih dan 3 ialah mempunyai masalah LD dan umur, namun didapati pada tahap 1, 33 saat masa di ambil oleh Pelatih 3 manakala 27 saat bagi Pelatih 2. Sebaliknya bagi tahap 3, Pelatih 3 mengambil masa 32 saat manakala Pelatih 2 hanya mengambil masa 26 saat untuk menyelesaikan tugasan. Ini kerana Pelatih 3 merupakan seorang wanita dan didapati wanita lebih peka dan cekap dalam proses mengingati sesuatu perkara (Niedźwieńska, A., & Zielińska, M., 2021).



Rajah 8. Masa menyelesaikan tugasan dikalangan Pelatih

5. Kesimpulan

Secara keseluruhannya ABM ISRK ini telah mencapai objektif yang disasarkan iaitu merekabentuk ABM yang berkonsepkan rak kasut bagi meningkatkan tahap kemahiran pengurusan diri dan motor halus para pelatih di PDK Teluk Kemang yang menghadapi permasalahan dalam pembelajaran bagi merangsang pelatih yang mempunyai masalah seperti LD, Autism, ADHD dan sebagainya.

Rekabentuk Ergonomik & Pendidikan yang merupakan ciri utama dalam rekabentuk ABM ISRK yang mana Ketinggian dan saiz direka supaya mesra OKU boleh diakses oleh individu dengan pelbagai tahap keupayaan fizikal. Aktiviti yang interaktif dan Kemahiran motor halus menerusi manipulasi objek kecil, butang, dan panel aktiviti dan Kemahiran Motor

Kasar melalui penggunaan kedua-dua tangan, angkat kasut, atau berinteraksi dengan komponen yang memerlukan kekuatan ringan mampu merangsang sentuhan, visual, dan kognitif pelajar OKU. Oleh itu alat ini mampu mengasah kemandirian pelatih dengan meletakkan kasut dengan betul, mengenal tempat simpanan, dan menyusun semula.dan mengenalpasti Kognitif dan Sensori melalui warna, tekstur dan susun atur membantu dalam pembelajaran asas bentuk, warna, dan penyusunan.

Reka bentuk ABM ISRK ini adalah satu inovasi yang praktikal dan berimpak tinggi untuk meningkatkan kemahiran kendiri dan motor dalam kalangan kanak-kanak OKU. Struktur yang kukuh, fleksibel dan boleh disesuaikan dengan keperluan terapi. Ini menjadikannya sangat sesuai digunakan dalam sesi latihan kendiri berasaskan permainan (*play-based therapy*) yang menyeronokkan dan bermanfaat.

Projek ini juga telah berjaya mendapat pengikhtirafan dengan kejayaan mendapat Gold Award Innovation on Mechaday 2023 at Politeknik Port Dickson, Produk ini juga Sijil Perhargaan dan pengiktirafan sebagai Gold Award Innovation dan First Runner Up bagi kategori Best Exhibitors berperluang menyertai pertandingan The 8th Regional Educators And Students Product's Exhibition (Respex) 2023 yang melibatkan beberapa Politeknik di peringkat antarabangsa. Antaranya adalah Politeknik Medan, Politeknik Padang, Politeknik Tun Syed Nasir dan banyak lagi. Dapatan kajian ini bukan sahaja menyumbang kepada bidang pendidikan khas dengan menyediakan ABM dalam proses pembelajaran pengurusan diri malahan ianya boleh dijadikan model produk yang berpotensi dikembangkan di institusi PDK lain secara lebih meluas.

Pengakuan
Kajian ini adalah kerjasama dari Politeknik Kota Kinabalu, Politeknik Port Dickson, Agensi luar seperti Persatuan Teknologi Malaysia (TAM) dan Pertubuhan PDK Telok Kemang.

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Effectiveness Of the Conference Management System (ICMS) Design

Sharifah Aznee binti Said Ali @ Syed Ali [1*], Baharin bin Ahmad[2] and Mohamad Siri bin Muslimin[3]

[1]Department of Mechanical Engineering,
Politeknik Kota Kinabalu,
No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, 88460 Kota Kinabalu, Sabah

[2]Department of Civil Engineering, Politeknik Port Dickson
KM 14, Jalan Pantai, 71050 Si Rusa, Port Dickson, Negeri Sembilan.

[3]Department of Commerce, Politeknik Port Dickson
KM 14, Jalan Pantai, 71050 Si Rusa, Port Dickson, Negeri Sembilan.

*aznee@polikk.edu.my

Abstract

Conferences and innovation competitions are actively organized to provide opportunities for researchers to share knowledge and research findings. Efficient management is very necessary to smooth the registration process, review by the panel, payment, and issuance of certificates after completion of the program. This study involved a questionnaire consisting of 2 main sections, namely demographics and Level of Satisfaction using ICMS, which were labelled R1-R10 and K1-K10, respectively. This questionnaire was distributed among 53 participants, the committee, and the evaluation panel. analysis processed using SPSS on Descriptive statistical methods such as mean, percentage and standard deviation. the result show that R7 is the highest Mean Score for ICMS System Design with 4.57 and the highest Mean Score for ICMS System Effectiveness Feedback is K2 with 4.64. this indicate that ICMS is well-designed information and by using ICMS platform can reduce time and energy especially registration and administration process. Therefore, Correlation Analysis for ICMS System Design have strong significant correlation among R3 - R9 and R4 - R5 with 0.852. like Correlation Analysis for the Effectiveness of the ICMS have strong significant correlation between K3 - K11 with 0.856. this outcome can used in predict modelling, feature selection, and regression analysis. In the future research, this study potential to investigate the highly correlated variables identified in the ICMS System Design and Effectiveness criteria can be utilized for predictive modelling and system optimization.

Keywords: *Innovation competitions, conferences, management, ICMS, design*

1. Introduction

The conference platform serves as a strategic collaborative avenue for researchers, academics, students, and industry partners to disseminate research findings, explore emerging technologies, and broaden professional networks within their respective fields (Kuzhabekova & Temerbayeva, 2018). The Department of Polytechnic and Community College Education (JPPKK) serves as a center for research development, innovation and commercialization for the education system at polytechnics and community colleges. JPPKK is directly involved in organizing conferences and innovation competitions at the national and international levels (Ministry of Higher Education Malaysia, 2020). There are also institutions that organize collaborative conference platforms involving two or more institutions at the local and international levels. This platform aims to promote knowledge exchange, networking and professional development, especially in carrying out impactful research and innovation projects (Abu Bakar et al., 2019).

However, the main challenges in organizing conferences are the issues of managing participant registration, payment of fees by participants, review of panel papers, and issuance of certificates after the program is completed. This process often takes quite a long time because

it is manually executed or involves multiple entities. According to Rai (2016), manually managing tasks such as registration, submission, review, and post-event documentation can be highly inefficient and burdensome for event organizers. Consequently, digital solutions have been explored and implemented to streamline conference management processes.

The development of the Innovation & Conference Management System (ICMS) platform is a digital initiative offering an alternative to help more efficient conference management. The system was developed in combination to facilitate the process of registration of participants, payment for the collection of participation fees, submission and review of papers for the evaluation panel, and automatic generation of e-certificates. By improving operational efficiency, it can reduce administrative workload because the ICMS system focuses on a single platform for all references. ICMS supports a broader agenda towards modernizing event management in higher education institutions (Ismail et al., 2022). The main objective of this study is to evaluate the effectiveness of the ICMS design and to examine the relationship between the system design features and its overall functional performance.

2. Methodology

Figure 1 shows a flowchart for the Conference Management System (ICMS) Design Effectiveness Study workflow process. This study uses a quantitative approach in the form of a structured questionnaire distributed through Google Forms, a tool commonly used to collect survey data in educational research (Kiger & Varpio, 2020). The questionnaire is divided into two main sections, namely demographic information of the respondents and the second section focus on the level of user satisfaction regarding the ICMS platform. Section 1 has ten questions labeled as R1 to R10 to assess the system design, while Section 2 includes eleven questions labeled K1 to K11 to assess the effectiveness of the ICMS.

The developed questionnaire was validated by a committee appointed to ensure content validity, as recommended in the questionnaire design literature (Boateng et. al., 2018). The questionnaire was distributed to 53 respondents, consisting of participants, committee members, and evaluation panel members who had experience using the developed ICMS system. The data collected were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0, due to its strong statistical reliability and ease of use in handling social science data (Azhar & Mahamod, 2018). According to Yusof et. Al (2022), SPSS was used its ability to generate high reliability coefficients, especially providing Cronbach's alpha values of 0.8 or higher. The analysis involved descriptive statistical methods such as mean, percentage, and standard deviation to interpret the data and generate findings for evaluation and improvement of the system.

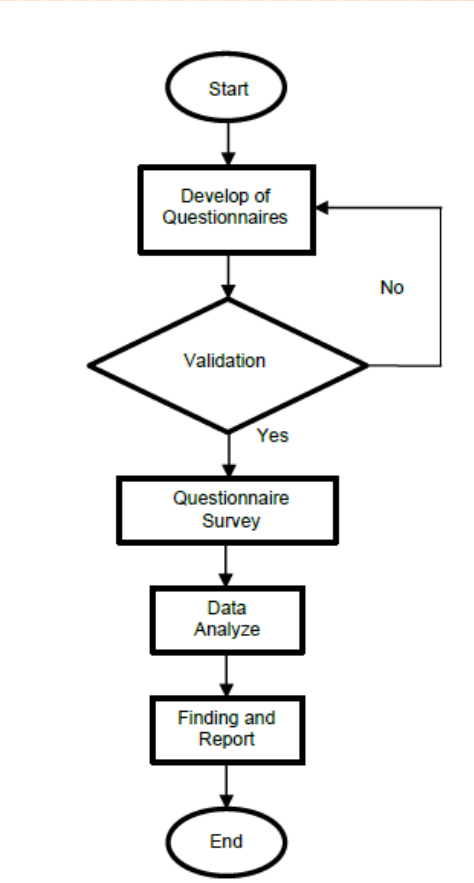


Figure 1: Flowchart of the research

Table 1 shows the instrument statements for the 10 main System Design items in the questionnaire. Each of these 10 items is labelled R1 to R10 referring to the instrument statement.

Table 1: Criteria, Instrument Item and Code of System Design

Criteria	Instrument Item	Code
	The ICMS system design is very easy to use	R1
	The ICMS system design is simple and appropriate	R2
	The ICMS system design is very user-friendly	R3
	The ICMS system design uses appropriate font types	R4
	The ICMS system design has appropriate text sizes	R5
System Design	The ICMS system is easy to assess via mobile phones and is easy to use	R6
	This application displays information immediately	R7
	The ICMS system design is very easy to update information	R8
	The ICMS system design has a complete combination of participant information	R9
	The ICMS system design is very easy to download letters, receipts and certificates	R10

Table 2 shows the instrument statements for the 11 main System Effectiveness Feedback items in the questionnaire. Each of these 11 items is labeled K1 to K11 referring to the instrument statement.

Criteria	Instrument Item	Code
System Effectiveness Feedback	Can the ICMS System be implemented quickly	K1
	Using the ICMS System can save time/energy	K2
	Registration/Payment/Check/Certificate Printing Management can be carried out efficiently, safely and effectively	K3
	Payment methods help avoid mistakes in the RESPEX 2023 account number	K4
	This ICMS system can be used without the help of others	K5
	The ICMS system requires a short time to master	K6
	Users can change any sub-topic at any time	K7
	Users are free to explore information	K8
	Users are free to exit the application at any time	K9
	The problem of waiting to deal with the JK RESPEX 2023 can be reduced	K10
	The ICMS system is suitable for use on the RESPEX organizational platform	K11

Table 2: Criteria, Instrument Item and Code of System Effectiveness Feedback

3. Results and Discussion

3.1 Demography

Figure 2 represents the distribution of ICMS Respondents by gender. it was found that Female respondents are 50% of the population compared to Male respondents which are 49% of the population.

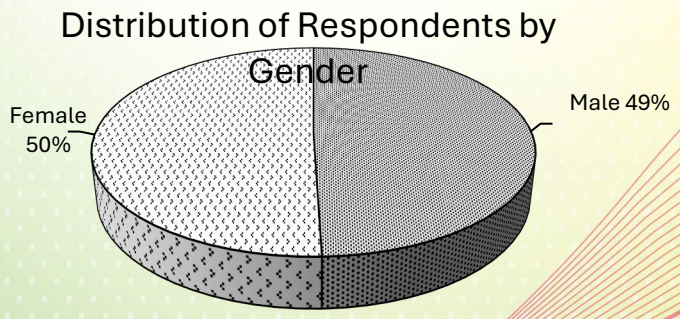


Figure 2: ICMS Respondent

Figure 3 illustrates the ICMS Participant in different categories. There are four groups of respondents namely student, lecturer, committee members and panels or juries. The student respondent representing the largest group 64% followed by lecturers19% of the participants. The Committee Members were 15% of the participants and Panel or Jury representing the smallest group 2% of the total participants.

Therefor participant distribution, emphasizing that students are the primary attendees, while lecturers and committees also play crucial roles. The panel or jury group remains the smallest due to their specialized role.

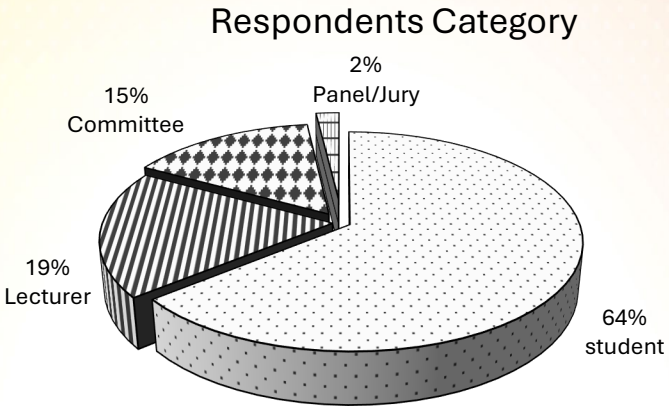


Figure 3: Category of ICMS Respondents

3.2 Analyse data

Figure 4 shows The Mean Score for ICMS System Design given by respondents for various Criteria related to the ICMS design representing questions R1 to R10. It was found that the overall Mean Score was High, because responses received scores above 4.4. This shows that respondents generally evaluated the system design positively, means it helped all categories of respondents. However, Criteria R7 had the highest score of 4.57, indicating that respondents found the system aspect of this application to display well-designed information. While Question R10 with a mean score of 4.42 was the lowest. R10 had the lowest rating, implying that the system aspect was quite weak compared to the other questions. The ICMS system design is very easy to download letters, receipts and certificates. Overall, the results show a strong positive reception of the ICMS system design. However, minor improvements can be made, especially in areas with slightly lower ratings.

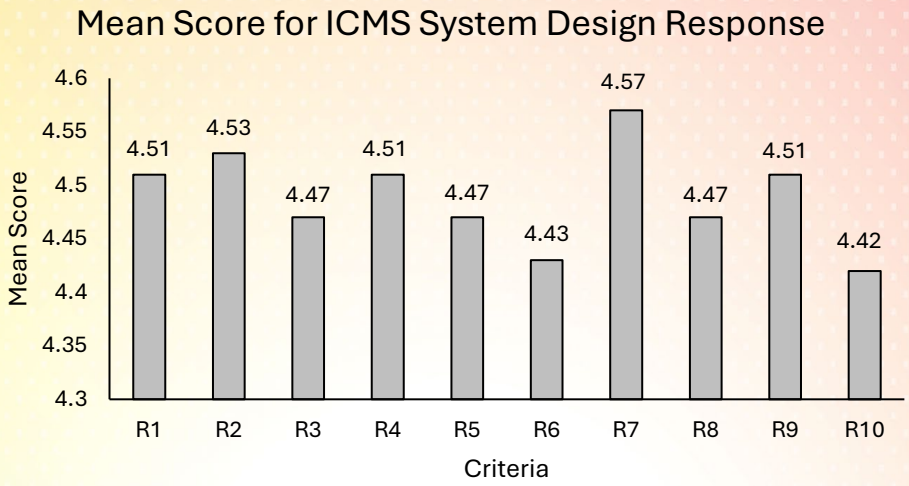


Figure 4: Mean Score for ICMS System Design

Figure 5 shows The Mean Score for ICMS System Effectiveness Feedback for different criteria K1 to K11. The y-axis displays the mean scores, while the x-axis lists the criteria (K1–K11). The High Mean Scores Across Most Criteria with most of the criteria received mean scores above 4.4, indicating a generally positive evaluation of the system's effectiveness. The Highest Rated Criteria was K2 with 4.64 mean score indicate that by using the ICMS System can save time and energy during process registration and administration conference. The Lowest Rated Criterion was K7 with mean score 4.42 indicates that users can change any sub-topic at any time. This might suggest an area that needs improvement. Overall, the respondent agreed that the ICMS system is considered effective, with certain criteria standing out as strengths, while others may need further enhancement.

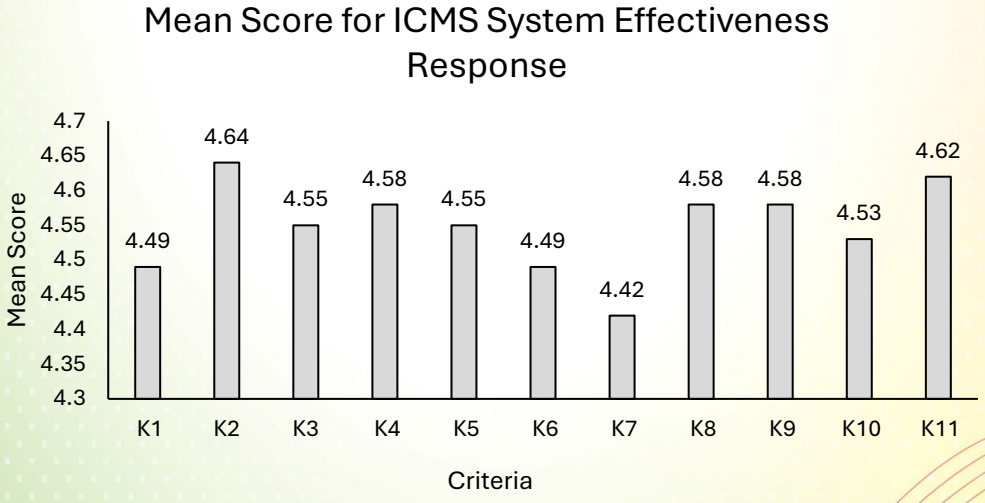


Figure 5: Mean Score for ICMS System Effectiveness Feedback

Table 3 represents the correlation coefficients for variables R1 to R10 related to ICMS System Design. A positive correlation indicates the strength and direction of a linear relationship between variables. Found a positive correlation that exceeds 0.75 between R3 and R9 (r = 0.852), between R4 and R5 (r = 0.852), which shows a high level of interdependence. Strong associations were also observed for R1–R3 (r = 0.776), R1–R9 (r = 0.774), and R6–R8

(r = 0.774). Similar to Schober, Boer & Schwarte (2018) findings that above 0.75 are classified as strong correlation coefficients, while values 0.50 and 0.75 indicates as moderate correlation.

Moderate correlations were recorded for R2–R5 (r = 0.666), R8–R10 (r = 0.641), and R6–R9 (r = 0.555). Conversely less correlations between R1–R8 (r = 0.398) and R1–R6 (r = 0.402), whereby both below the 0.50, that represent a weak linear association (Akoglu, 2018). These findings prove that elements of the ICMS system design are closely aligned may require further clarification to enhance the functionality of system.

Table 3: Significant Correlation Analysis for each question for ICMS System Design

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
R1	1	0.585**	0.776**	0.623**	0.776**	0.402**	0.512**	0.398**	0.774**	0.264
R2	0.585**	1	0.741**	0.660**	0.666**	0.751**	0.698**	0.590**	0.660**	0.517**
R3	0.776**	0.741**	1	0.549**	0.697**	0.545**	0.599**	0.546**	0.852**	0.586**
R4	0.623**	0.660**	0.549**	1	0.852**	0.707**	0.435**	0.700**	0.623**	0.540**
R5	0.776**	0.666**	0.697**	0.852**	1	0.622**	0.599**	0.621**	0.700**	0.531**
R6	0.402**	0.751**	0.545**	0.707**	0.622**	1	0.613**	0.774**	0.555**	0.525**
R7	0.512**	0.698**	0.599**	0.435**	0.599**	0.613**	1	0.446**	0.588**	0.475**
R8	0.398**	0.590**	0.546**	0.700**	0.621**	0.774**	0.446**	1	0.625**	0.641**
R9	0.774**	0.660**	0.852**	0.623**	0.700**	0.555**	0.588**	0.625**	1	0.540**
R10	0.264	0.517**	0.586**	0.540**	0.531**	0.525**	0.475**	0.641**	0.540**	1

** The correlation is significant at the 0.01 level (2-tailed)

Table 4 shows correlation coefficients for the complete set the effectiveness of the ICMS system for 11 variables (K1 to K11). The strongest correlation was identified between variables K3 and K11 (r = 0.856), followed by the relationship between K9 and K11 (r = 0.845). A similarly strong association was observed between K6 and K10 (r = 0.776). As suggested by Schober, Boer & Schwarte (2018), correlation coefficients exceeding 0.75 indicate a strong positive relationship. Moderate correlations were noted for K1–K9 (r = 0.750), K1–K3 (r = 0.741), K1–K5 (r = 0.741), and K3–K7 (r = 0.737), which are consistent with the conventional interpretation of medium-strength associations (Akoglu, 2018). In contrast, low correlation indicating a weak linear associationfor K6 and K11 (r = 0.375). However, negligible correlation emerged between K2 and K7 (r = 0.201) the absence of a meaningful relationship between these variables (Field, 2018). These variations in correlation strength offer insights into which components of ICMS effectiveness are closely interconnected and which may warrant further attention for system enhancement.

Table 4: Significant Correlation Analysis for each question for the Effectiveness of the ICMS System

	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11
K1	1	0.576**	0.741**	0.673**	0.741**	0.547**	0.482**	0.597**	0.750**	0.474**	0.764**
K2	0.576**	1	0.506**	0.568**	0.506**	0.497**	0.201	0.488**	0.488**	0.555**	0.636**
K3	0.741**	0.506**	1	0.695**	0.695**	0.514**	0.737**	0.541**	0.695**	0.431**	0.856**
K4	0.673**	0.568**	0.695**	1	0.695**	0.520**	0.620**	0.689**	0.689**	0.585**	0.687**
K5	0.741**	0.506**	0.695**	0.695**	1	0.665**	0.602**	0.541**	0.695**	0.735**	0.699**
K6	0.547**	0.497**	0.514**	0.520**	0.665**	1	0.616**	0.597**	0.444**	0.776**	0.375**
K7	0.482**	0.201	0.737**	0.620**	0.602**	0.616**	1	0.552**	0.552**	0.561**	0.504**
K8	0.597**	0.488**	0.541**	0.689**	0.541**	0.597**	0.552**	1	0.767**	0.508**	0.687**
K9	0.750**	0.488**	0.695**	0.689**	0.695**	0.444**	0.552**	0.767**	1	0.508**	0.845**
K10	0.474**	0.555**	0.431**	0.585**	0.735**	0.776**	0.561**	0.508**	0.508**	1	0.434**
K11	0.764**	0.636**	0.856**	0.687**	0.699**	0.375**	0.504**	0.687**	0.845**	0.434**	1

** The correlation is significant at the 0.01 level (2-tailed)

4. Conclusion

The conclusion of this study respondent about ICMS System Design, Criteria R7 had the highest score of 4.57, indicating that respondents found the system aspect of this application to display well-designed information. However, Respondent about System Effectiveness Feedback the highest rated Criteria was K2 with 4.64 mean score indicate that by using the ICMS System can save time and energy during process registration and administration conference. For the Correlation Analysis for ICMS System Design criteria R3 - R9 and R4 - R5 have strong significant correlation and positive were 0.852. meanwhile for the Correlation Analysis for the Effectiveness of the ICMS System K1 to K11. It was found that the correlation relationship is Strong between K3 - K11 which is the highest which is 0.856. Therefor the high correlations between certain variables indicate a close relationship, which can be useful in predictive modelling, feature selection, and regression analysis. The implications from high correlations between several variables may indicate that these factors are directly related and may influence each other.

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POLITEKNIK KOTA KINABALU

Kajian Keberkesanan Reka Bentuk Stesen Kerja Terhadap Masa Pemasangan Palam Tiga Pin

Sharifah Aznee Binti Said Ali @ Syed Ali[1]*, Mutiman Bin Mat[2], Muhammad Syukri Bin Mohamad Sainal[3]

[13]Jabatan Kejuruteraan Mekanikal, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park,Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah, Malaysia.

[2]Jabatan Kejuruteraan Mekanikal, Politeknik Nilai, Kompleks Pendidikan Nilai, Bandar Enstek, 71760 Labu, Negeri Sembilan

*aznee@polikk.edu.my

Abstrak

Reka bentuk stesen kerja memainkan peranan penting dalam mempengaruhi masa pemasangan peralatan elektrik seperti palam tiga pin. Masa pemasangan yang cekap bukan sahaja meningkatkan produktiviti dan kecekapan kerja, malah turut menyumbang kepada keselesaan pekerja. Kajian ini bertujuan untuk membandingkan masa pemasangan bagi lapan reka bentuk stesen kerja yang berbeza dalam proses pemasangan palam tiga pin. Kaedah utama kajian ialah gabungan antara reka bentuk eksperimen dan masa pemasangan telah digunakan bagi menilai prestasi setiap reka bentuk. Seramai 24 orang pelajar telah terlibat sebagai subjek dalam kajian ini. Mereka melaksanakan tugas pemasangan palam dalam pelbagai konfigurasi yang melibatkan bilangan operator, susunan komponen, dan posisi kerja. Hasil kajian menunjukkan bahawa terdapat perbezaan yang signifikan dalam masa pemasangan antara reka bentuk stesen kerja yang diuji. Dapatan utama menunjukkan bahawa reka bentuk stesen kerja dengan dua orang operator, susunan komponen di sisi, dan posisi kerja duduk memberikan masa pemasangan yang paling cepat. Namun begitu, bilangan operator dikenal pasti sebagai faktor yang paling memberi kesan terhadap masa pemasangan. Sumbangan kajian ini adalah menyediakan panduan praktikal dalam mereka bentuk stesen kerja yang lebih efisien bagi industri pemasangan komponen elektrik. Hasilnya boleh dimanfaatkan oleh pihak industri untuk meningkatkan produktiviti serta mengoptimumkan susun atur dan ergonomik di tempat kerja.

Kata kunci: *Reka Bentuk Stesen Kerja; Masa Pemasangan; Palam Tiga Pin; Operator; Postur;*

1. Pengenalan

Stesen kerja di industri adalah merujuk kepada ruang di mana pekerja samada secara individu atau lebih melaksanakan pekerjaan yang sesuai dengan skop tugasan. Stesen ini dilengkapi dengan pelbagai jenis bahan kerja seperti komponen, peralatan, dan juga mesin. Reka bentuk stesen kerja industri perlu menitikberatkan aspek ergonomik dengan mempertimbangkan hubungan antara operator, bahan, dan alat agar memastikan proses kerja dapat dijalankan secara produktif dan selesa. Justeru itu, pihak pengurusan industri perlu memberi keutamaan kepada isu-isu seperti kerja yang berulang, membosankan, dan meletihkan kerana ia memberi kesan langsung terhadap produktiviti serta kepuasan kerja operator (Patel & Chakraborty, 2021). Penekanan utama dalam aspek ergonomik dalam faktor reka bentuk seperti susunatur peralatan dan jarak kerja mampu meningkatkan prestasi dan kualiti kerja, di samping mengurangkan tekanan fizikal terhadap operator (Singh et al., 2020). Dapatan dari kajian lalu membuktikan bahawa reka bentuk stesen kerja yang ergonomik mampu meningkatkan kualiti, produktiviti, keselesaan kerja, dan pengurangan kos (Rahman et al., 2023; Zare et al., 2022).

Manakala, kelemahan dalam menyesuaikan keupayaan operator dengan keperluan tugas dalam reka bentuk stesen kerja boleh menyebabkan pengurangan produktiviti dan peningkatan risiko kecederaan pekerjaan (Schulte et al., 2024). Menurut Ali & Baharom (2021), apabila

operator bekerja di stesen kerja yang ergonomik, tahap produktiviti akan meningkat. Oleh itu faktor manusia seperti pengalaman psiko-fizikal, postur tubuh, dan aktiviti otot, dan faktor persekitaran kerja seperti tahap bunyi, getaran, dan keselesaan perlu diberi perhatian serius dalam mereka bentuk stesen kerja industri yang ergonomik. Terdapat hubungan positif yang signifikan antara keselesaan dan prestasi produktiviti operator di stesen kerja (Lim et al., 2021; Kim & Park, 2020). Selain daripada itu, faktor seperti berat peralatan, ketinggian kerja, dan jarak pergerakan operator juga dikenal pasti sebagai pemboleh ubah kritikal yang boleh memaksimumkan prestasi serta mengurangkan kos pengeluaran (Sulaiman & Ishak, 2022). Satu kajian terhadap pemasangan menunjukkan peningkatan produktiviti adalah lebih ketara semasa tempoh permintaan tinggi apabila operator bekerja dalam susunan bentuk-U berbanding barisan lurus (Tan et al., 2022).

Menurut Hilmi et al. (2024) boleh dua kategori pekerjaan dalam industri pembuatan iaitu kerja ketepatan dan kerja berat. Bagi kerja ketepatan, ketinggian bekerja yang disarankan adalah pada paras atas siku, manakala bagi kerja berat pula, ketinggian bekerja yang lebih rendah daripada paras siku adalah lebih sesuai kerana ia membolehkan penggunaan berat badan bahagian atas untuk menghasilkan daya tangan secara menegak ke bawah (Hilmi et al., 2024). Moustafa, A. W., & Gharib, I. (2024) mencadangkan ketinggian bekerja yang sesuai untuk lelaki bagi kerja ketepatan ialah antara 100–110 cm, untuk kerja ringan sekitar 90–95 cm, dan bagi kerja berat sekitar 75–90 cm (Tanaka & Lee, 2020). Di stesen kerja, tugas boleh dilakukan secara berdiri atau duduk. Posisi berdiri lebih sesuai untuk kerja yang memerlukan pergerakan kerap, pengendalian objek besar atau berat, serta penggunaan daya yang tinggi. Manakala, kerja dalam posisi berdiri dalam tempoh lama boleh menyebabkan ketidakselesaan badan dan keletihan otot. Sebaliknya, kerja dalam posisi duduk lebih sesuai untuk kerja jangka panjang kerana ia memberikan kawalan yang lebih baik terhadap pergerakan lengan dan keseimbangan badan (Karwowski & Zhang, 2021). Kajian terkini turut menggunakan pendekatan reka bentuk eksperimen (DoE) untuk menilai pelbagai faktor yang mempengaruhi produktiviti, seperti bilangan operator, susun atur komponen, dan posisi bekerja (Zhou et al., 2020). Dengan gabungan pendekatan ini, reka bentuk stesen kerja boleh dioptimumkan untuk meningkatkan produktiviti dan mengurangkan risiko kecederaan, sekali gus menyokong kecekapan dan kesejahteraan jangka panjang pekerja industri.

2. Kajian Literasi

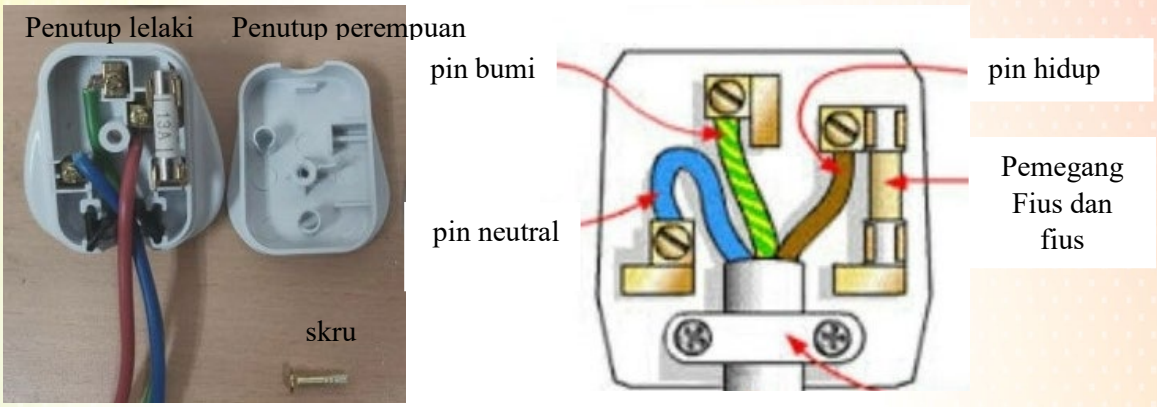
Dalam proses pemasangan palam soket elektrik, beberapa faktor ergonomik dan reka bentuk stesen kerja memainkan peranan penting dalam mempengaruhi masa kitaran kerja. Dapatan kajian Attia et al. (2023) menunjukkan penggunaan jig dan ketinggian meja kerja yang sesuai dapat mengurangkan keletihan dan meningkatkan kecekapan kerja operator. Namun, susunan komponen di stesen kerja juga merupakan aspek kritikal yang sering diabaikan. Susunan komponen seperti sisi dan bentuk U terbukti memberi kesan langsung terhadap kelajuan dan kelancaran proses kerja, khasnya dalam persekitaran kerja berulang seperti pemasangan elektrik (Alipour, Daneshmandi, Fararuei, & Zamanian, 2021). Merujuk kajian yang telah dijalankan Bertolini et al. (2020) mendapati bahawa peningkatan bilangan operator akan memberi kesan kepada peningkatan masa pemasangan kerana wujudnya kesan pergerakan koordinasi dan postur antara operator. Perbezaan dalam reka bentuk susun atur ini boleh menjejaskan kadar produktiviti, pergerakan operator, serta keselesaan kerja. Oleh itu, kajian mengenai kesan kombinasi faktor seperti bilangan operator, susunan komponen, dan kedudukan kerja adalah penting bagi menentukan susun atur stesen kerja yang optimum. Penemuan kajian sebegini bukan sahaja menyumbang kepada peningkatan produktiviti tetapi

juga menyokong reka bentuk kerja berasaskan ergonomik, yang boleh mengurangkan risiko kecederaan muskuloskeletal dan meningkatkan kepuasan kerja operator.

3.0 Metodologi

3.1 Eksperimen

Pemasangan Palam Tiga Pin telah dipilih untuk menjalankan eksperimen. Rajah 1 menunjukkan Palam Tiga Pin yang terdiri dari lapan komponen utama iaitu: penutup perempuan, pin neutral, pin bumi, pin hidup, pemegang fius, fius, penutup lelaki dan satu skru. Manual bagi skru *driver* disediakan bagi pemasangan Palam Tiga Pin. Makmal Mekatronik dilengkapi dengan penghawa dingin dan mempunyai kualiti udara dalaman yang baik.



Rajah 1. Komponen Palam Tiga Pin

Bagi semua lapan komponen Palam Tiga Pin di masukkan dalam lapan kotak pemasangan yang dipisahkan untuk menjalankan eksperimen. Rajah 2 menunjukkan agihan komponen dalam setiap kotak iaitu Kotak 1-penutup perempuan; Kotak 2- pin bumi; Kotak 3- pin neutral; Kotak 4- pin hidup; Kotak 5- pemegang fius; Kotak 6- fius; Kotak 7- penutup lelaki; Kotak 8-skru. Kotak pemasangan terletak di bahagian atas meja dan disusun dari kiri ke kanan mengikut proses pemasangan berikut:

1. Penutup perempuan Palam Tiga Pin diletakkan di atas meja;
2. Pin bumi dimasukkan ke dalam segi empat tepat tengah atas lubang penutup perempuan;
3. Pin neutral dimasukkan ke dalam segi empat tepat bawah lubang pada penutup perempuan kiri;
4. Pin hidup dimasukkan ke dalam lubang segi empat tepat bawah pada penutup perempuan kanan;
5. Pemegang fius dimasukkan dalam penutup perempuan;
6. Fius dimasukkan ke dalam pemegang fius;
7. Penutup lelaki dipasangkan pada penutup perempuan Palam Tiga Pin. Kedua-dua penutup ini ditekan bersama-sama untuk memastikan ia tetap kukuh;
8. Skru dimasukkan ke dalam lubang bulat tengah penutup perempuan.
9. Langkah terakhir ialah mengetatkan skru mengikut arah jam arah menggunakan pemacu skru. Masa perhimpunan telah direkodkan dari proses pertama hingga terakhir proses.

2.2 Rekabentuk

Seramai 24 pelajar dari Diploma Kejuruteraan Mekatronik telah dipilih dalam melaksanakan ekperimen ini sebagai operator. Sebelum menjalankan ekperimen ini, pelajar

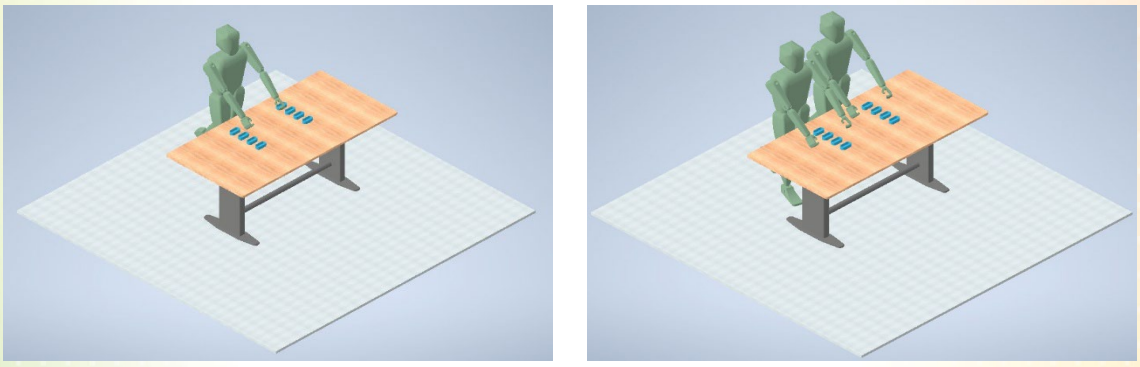
diterangkan dengan prosedur dan mereka diberikan masa agar dapat membiasakan diri dengan peralatan dan prosedurnya. Para pelajar diingatkan supaya melakukan eksperimen ini mengikut kadar mereka sendiri. Ketetapan melakukan ekperimen seperti dalam Jadual 1 bagi penetapan rekabentuk eksperimen yang terdiri daripada tiga faktor utama yg diuji dalam eksperimen iaitu bilangan operator (OPERATOR) iaitu satu atau dua, susunan komponen (SUSUNAN) secara bentuk U atau Sisi dan posisi kerja (POSISI) secara duduk atau berdiri. Oleh itu 8 kombinasi Susunatur kerja (SK) eksperimen yang akan dijalankan berdasarkan faktor dan tahap.

Jadual 1. Reka bentuk eksperimen

Operator	SATU				DUA			
Susunan	U		SISI		U		SISI	
Posisi	D	B	D	B	D	B	D	B
Susunatur kerja (SK)	SK1	SK2	SK3	SK4	SK5	SK6	SK7	SK8

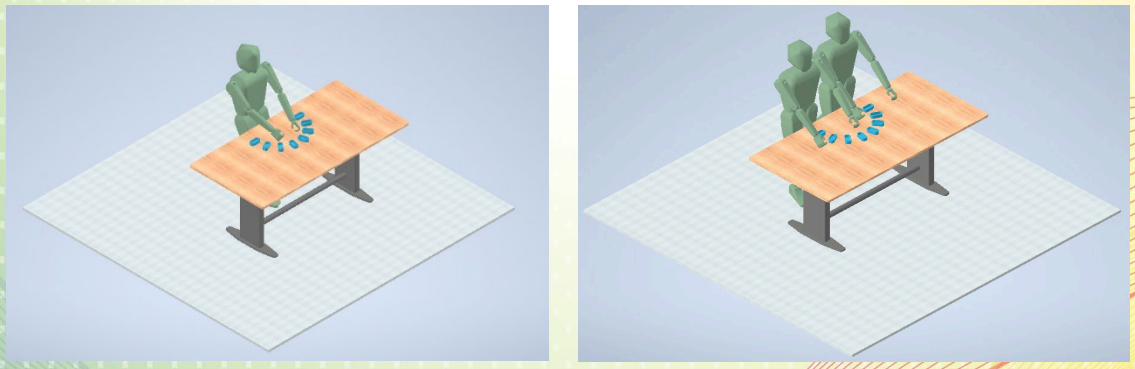
(*D= Duduk, B=Berdiri)

Rajah 2 menunjukkan gambaran isometrik bagi rekabentuk eksperimen yang dijalankan bagi susunan komponen secara sisi dan posisi secara berdiri dengan bilangan operator secara seorang atau berdua.



Rajah 2. Posisi berdiri bagi operator seorang dan berdua dengan sususan sisi

Rajah 3 menunjukkan gambaran isometrik bagi rekabentuk eksperimen yang dijalankan bagi susunan komponen secara bentuk U dan posisi secara berdiri dengan bilangan operator secara seorang atau berdua.



Rajah 3. Posisi berdiri bagi operator seorang dan berdua dengan sususan bentuk U

4.0 Dapatan Dan Perbincangan

Jadual 2 menunjukkan data statistik bagi lapan susunatur kerja (SK 1 hingga SK 8) yang digunakan dalam pemasangan Palam Tiga Pin, parameter yang dianalisis termasuk nilai minimum (Min), purata (Mean), maksimum (Max), varians, dan sisihan piawai (SD). Didapati SK 1 mencatat purata masa pemasangan tertinggi iaitu 25.80s, manakala SK 7 mencatat purata masa terendah iaitu 21.4s. Ini menunjukkan SK 7 mungkin paling efisien dari segi masa berbanding SK1. Ini kerana SK 1 dikendalikan oleh sorang operator dengan Posisi bekerja duduk sususan secara bentuk U manakala SK7 dikendalikan oleh dua operator dengan Posisi bekerja duduk sususan secara sisi.

Seterusnya bagi bacaan Varians dan sisihan piawai menunjukkan bacaan yang stabil bagi masa pemasangan dalam setiap susunatur kerja yang mana SK 7 mempunyai varians 10.4s dan sisihan piawai 3.2s terendah, menandakan bahawa masa pemasangan dalam susunatur ini paling konsisten berbanding SK 1 mempunyai varians 40.9s dan SD 6.4s tertinggi, menunjukkan ketidaktentuan atau variabiliti tinggi dalam masa pemasangan. Dari analisis ini, dapat disimpulkan bahawa susunatur kerja memainkan peranan penting dalam mempengaruhi masa dan kestabilan pemasangan. Susunatur seperti SK 7 dan SK 8 berpotensi untuk diterapkan atau dijadikan model dalam reka bentuk stesen kerja kerana memberikan masa pemasangan yang lebih rendah dan konsisten. Ini dapat membantu meningkatkan produktiviti dan keberkesanan proses pemasangan palam Tiga Pin.

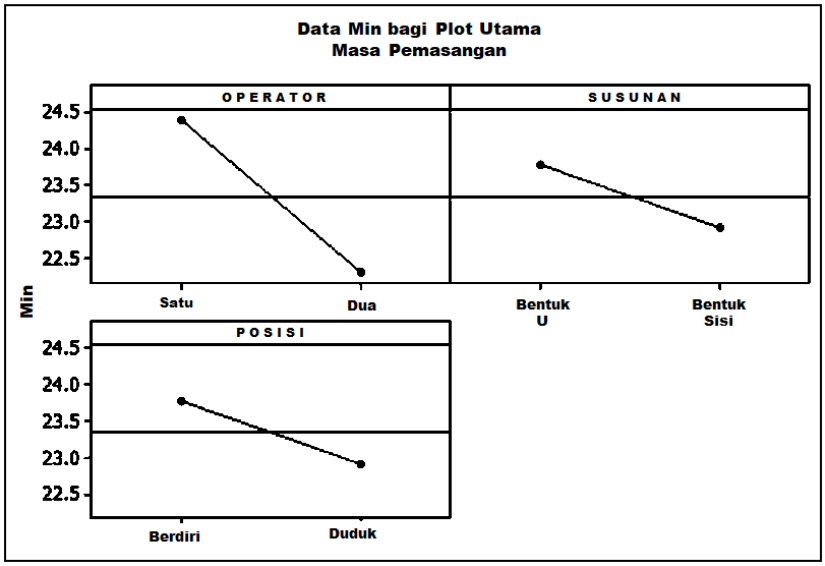
Didapati bilangan operator dan susun atur susunan komponen memberi kesan kepada masa pemasangan Palam Tiga Pin. Melalui eksperimen ini, terdapat kelebihan mempunyai lebih operator dalam melaksanakan tugas. Ini kerana apabila bilangan komponen berkurang mampu menyebabkan operator lebih fokus dalam melaksanakan tugas mereka dan mampu mengurangkan masa pemasangan dan dapat melakukan lebih banyak kerja akhirnya mengoptimumkan kecekapan dan produktiviti dan seterusnya mengurangkan kos pengeluaran seunit yang dihasilkan. Kajian ini mengenal pasti bahawa susun atur bentuk U tidak sentiasa menyumbang masa pemasangan yang baik walaupun walaupun susun atur ini telah terbukti lebih produktif daripada susun atur sisi (Alduaij & Hassan, 2020).

Jadual 2. Minimum, mean, maksimum, dan sisihan piawai (SD) masa pemasangan untuk setiap stesen kerja

Susunatur kerja (SK)	Min	Mean	Max	Varians	Sisihan piawai (SD)
SK 1	14.47	25.80	55	40.9	6.4
SK 2	15	24.6	64	35	5.9
SK 3	14	23.6	53.8	28.6	5.3
SK 4	14.3	23.5	48.1	25.9	5
SK 5	13	22.5	45	26.9	5.2
SK 6	14.3	22.2	51	15.3	3.9
SK 7	15	21.4	43.3	10.4	3.2
SK 8	12	23.1	47.3	33	5.8

Rajah 4 menunjukkan Kesan individu operator, susunan dan kedudukan yang sepadan dengan masa pemasangan, di mana kecerunan yang lebih besar menunjukkan kesan yang lebih besar dalam proses perhimpunan. Plot kesan utama menunjukkan:

- Masa pemasangan Palam Tiga Pin dikurangkan apabila menggunakan lebih operator. Bilangan operator mempengaruhi dan mengurangkan masa pemasangan.
- Penyusunan komponen yang betul boleh mengurangkan masa pemasangan. Ini kerana masa pemasangan komponen diatur di ssecara sisi lebih rendah berbanding dengan susuan bentuk U.
- Kedudukan bekerja sama ada berdiri atau duduk turut mempunyai kesan untuk masa pemasangan. Kajian ini menunjukkan posisi berdiri adalah lebih produktif daripada posisi duduk.



Rajah 4. Plot utama untuk masa pemasangan palam tiga pin

Berdasarkan plot utama masa pemasangan, didapati kecerunan bagi bilangan operator adalah yang terbesar berbanding cara penyusunan komponen dan posisi operator semasa melaksanakan tugas memasang Palam Tiga Pin.

5. Kesimpulan

Berdasarkan kajian ini disimpulkan terdapat perbezaan yang signifikan dalam masa pemasangan bagi lapan jenis reka bentuk palam tiga pin. Masa pemasangan lebih cepat bagi dua orang operator dengan menggunakan reka bentuk susunan sisi dalam keadaan posisi duduk. Sebaliknya masa pemasangan lama bagi seorang operator yang bekerja dalam keadaan posisi duduk dan reka bentuk susunan bentuk U. Dapatan ini jelas menunjukkan bilangan operator dan reka bentuk susunan komponen mempengaruhi masa pemasangan palam tiga pin. Dapatan kajian ini boleh dikembangkan kepada penilaian faktor ergonomik lain seperti ketinggian meja kerja, penggunaan peralatan sokongan, pencahayaan tempat kerja yang berpotensi mempengaruhi masa pemasangan dan kecekapan operator. Pendekatan kajian secara simulasi menggunakan teknologi realiti maya (VR) atau analisis pergerakan (*motion analysis*) juga boleh dijalankan untuk mendapatkan pemahaman yang lebih mendalam terhadap interaksi antara reka bentuk susunan komponen, postur kerja dan keberkesanan pemasangan palam tiga pin.

Pengakuan
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Kajian Keperluan Pembangunan Aplikasi Mudah Alih eReport V2.0 Bagi Subjek Projek di Kolej Komuniti Pasir Gudang, Johor

Noorashikin Binti Mustafa[1], Irma Binti Maaman[2], Haslina Binti Tawyer[3]

[1,2,3]Kolej Komuniti Pasir Gudang, No 61, Jalan Kijang, Taman Scientex, 81700 Pasir Gudang, Johor, Malaysia.

shikin@kkpg.edu.my

Abstract

This study was conducted to identify the development needs of the eReport V2.0 application as a reporting platform and learning support tool for the Project subject in the Information Technology Certificate (STM) program at Kolej Komuniti Pasir Gudang. A total of 31 respondents, comprising 23 Semester I 2023/2024 students and 8 STM lecturers, participated in the study. A structured questionnaire was used, consisting of three main sections: respondent information, weaknesses of the existing reporting methods, and requirements for a new system. The questionnaire employed a 5-point Likert scale to measure respondents' level of agreement regarding the limitations of the current system and the need for a new one.Findings show that the majority of respondents strongly agreed that the existing reporting methods—namely manual logbooks and Google Forms—had various limitations in terms of time management, information accessibility, and efficiency of feedback delivery. The study also revealed a very high demand for the development of a new application that is more systematic, interactive, and user-friendly. One of the key requirements identified is the inclusion of a module within the application that provides access to syllabus content, lecture notes, assessments, and up-to-date video references to support effective learning.The analysis revealed that 100% of respondents strongly agreed on the need for a new system, with mean scores for all system requirement items ranging from 4.87 to 5.00. As for the weaknesses of the current system, mean scores ranging from 4.65 to 4.87 indicated a very high level of agreement regarding its ineffectiveness. A Cronbach's Alpha coefficient of 0.82 further confirmed that the questionnaire instrument had a high and consistent level of reliability. The findings of this study provide a solid foundation for the development of eReport V2.0, which not only improves the project reporting process but also functions as a comprehensive integrated learning platform.

***Keywords**: eReport V2.0, project reporting, digital system, integrated learning, Community College.*

Abstrak

Kajian ini dijalankan bagi mengenal pasti keperluan pembangunan aplikasi eReport V2.0 sebagai platform pelaporan dan sokongan pembelajaran bagi Subjek Project, Sijil Teknologi Maklumat (STM) di Kolej Komuniti Pasir Gudang. Kajian melibatkan seramai 31 responden terdiri daripada 23 orang pelajar Sesi I 2023/2024 dan 8 orang pensyarah STM, menggunakan instrumen soal selidik yang merangkumi tiga bahagian: maklumat responden, kelemahan kaedah pelaporan sedia ada, dan keperluan sistem baharu. Instrumen soal selidik berstruktur digunakan dengan skala Likert 1 hingga 5 untuk mengukur tahap persetujuan responden terhadap kelemahan sistem sedia ada dan keperluan sistem baharu. Dapatan kajian menunjukkan bahawa majoriti responden sangat bersetuju bahawa sistem pelaporan sedia ada iaitu buku log manual dan Google Form mempunyai pelbagai kekangan dari segi pengurusan masa, kebolehaksesan maklumat serta kecekapan penyampaian maklum balas. Kajian juga menunjukkan keperluan yang sangat tinggi terhadap pembangunan aplikasi baharu yang lebih sistematik, interaktif dan mesra pengguna. Salah satu keperluan utama yang juga dikenalpasti ialah pembangunan modul aplikasi yang mengandungi silibus, nota, penilaian dan rujukan video terkini bagi menyokong keberkesanan pembelajaran. Hasil analisis menunjukkan bahawa 100% responden sangat bersetuju dengan keperluan pembangunan sistem baharu, dengan nilai min bagi kesemua item keperluan sistem antara 4.87 hingga 5.00. Bagi kelemahan sistem sedia ada, nilai min antara 4.65 hingga 4.87 menunjukkan tahap persetujuan yang sangat tinggi terhadap ketidakberkesanan sistem terdahulu. Nilai pekali Alpha Cronbach sebanyak 0.82 turut menunjukkan kebolehpercayaan instrumen soal selidik adalah tinggi dan konsisten. Hasil kajian ini memberikan asas yang kukuh untuk membangunkan eReport V2.0 yang bukan sahaja menambah baik proses pelaporan projek, malah berfungsi sebagai platform pembelajaran bersepadu yang menyeluruh.

***Kata kunci:** eReport V2.0, pelaporan projek, sistem digital, pembelajaran bersepadu, Kolej Komuniti*

1.0 Pengenalan

Dalam era digital yang semakin berkembang, keperluan kepada sistem pelaporan yang lebih cekap dan mesra pengguna semakin mendesak, terutama dalam konteks pendidikan teknikal dan vokasional. Sistem pelaporan tradisional seperti buku log manual dan borang dalam talian seperti Google Form (eReport V1) didapati mempunyai pelbagai kelemahan yang mengganggu keberkesanan proses pembelajaran dan pemantauan projek pelajar. Pelaporan secara manual sering melibatkan pengisian buku log harian, lembaran penilaian bercetak, atau laporan berjadual yang dihantar secara fizikal kepada pensyarah. Walaupun kaedah ini membolehkan dokumentasi disimpan dalam bentuk bertulis, ia sering menimbulkan masalah dari segi kebolehbacaan tulisan tangan, kehilangan bahan fizikal, dan kesukaran pensyarah membuat semakan berkala secara fleksibel.

Sementara itu, beberapa institusi telah mula beralih kepada pelaporan berasaskan aplikasi digital seperti Google Classroom, Microsoft Teams, dan Padlet untuk menggalakkan interaksi serta penyampaian bahan pembelajaran secara lebih fleksibel dan tersusun (Iftakhar, 2016; Rathod et al., 2021; Guerrero et al., 2024). Aplikasi-aplikasi ini menyokong pembelajaran kendiri dan kolaboratif, selain menyediakan ruang untuk guru atau pensyarah memberi maklum balas dalam masa nyata. Walau bagaimanapun, aplikasi ini lebih tertumpu kepada tugasan umum dan penyampaian nota, dan bukan direka khas untuk pengurusan laporan projek berstruktur secara mingguan, pemantauan progres pelajar secara berterusan, atau pengumpulan maklum balas dalam satu platform terpusat. Sehubungan itu, pembangunan aplikasi eReport V2.0 dicadangkan sebagai satu penambahbaikan menyeluruh kepada kaedah pelaporan sedia ada. Aplikasi ini disasarkan untuk menyediakan fungsi pelaporan projek yang lebih sistematik, tersusun mengikut minggu, serta dilengkapi dengan capaian kepada rekod maklum balas terdahulu, sekaligus memudahkan semakan semula oleh pelajar dan pensyarah. Pelaporan secara digital dan bersepadu merupakan antara pendekatan penting dalam pendidikan abad ke-21, khususnya melalui penggunaan teknologi mudah alih yang menyokong pembelajaran fleksibel dan berpusatkan pelajar (Ally, 2009).

Kajian ini bertujuan untuk mengenal pasti keperluan sebenar pengguna, iaitu pelajar dan pensyarah, terhadap pembangunan aplikasi eReport V2.0 berdasarkan pengalaman penggunaan sistem sedia ada dan jangkaan terhadap ciri-ciri dalam sistem baharu. Selain fungsi pelaporan, keperluan terhadap modul kandungan pembelajaran seperti silibus, nota kuliah, penilaian berstruktur, dan rujukan video juga dikenalpasti sebagai komponen utama dalam pembangunan sistem ini bagi menyokong keberkesanan pengajaran dan pembelajaran projek secara holistik dan kontemporari.

2.0 Penyataan Masalah

Pelaporan projek pelajar di Kolej Komuniti Pasir Gudang masih menggunakan kaedah konvensional seperti penulisan buku log manual dan Google Form. Kaedah ini menimbulkan beberapa isu, antaranya ialah kesukaran dalam penyimpanan data, kekangan dalam menyemak laporan terdahulu, kelemahan dalam sistem maklum balas, serta antara muka sistem yang tidak mesra pengguna. Tambahan pula, kandungan pembelajaran yang disediakan tidak dikemaskini mengikut kurikulum semasa, menyebabkan proses pembelajaran menjadi kurang berkesan.

Hasil pemerhatian awal dan maklum balas tidak formal menunjukkan ketidakpuasan hati dalam kalangan pensyarah dan pelajar terhadap sistem pelaporan sedia ada. Justeru, wujud keperluan untuk membangunkan sistem pelaporan projek berasaskan aplikasi mudah alih yang

bukan sahaja memperkemas proses pelaporan dan pemantauan, tetapi juga menyediakan modul pembelajaran yang terkini dan boleh diakses dengan mudah oleh semua pihak yang terlibat.

3.0 Objektif Kajian

Terdapat dua objektif bagi kajian ini, iaitu:-

1. Mengenal pasti kelemahan sistem pelaporan projek sedia ada.
2. Menganalisis keperluan pelajar dan pensyarah terhadap pembangunan sistem baharu.

4.0 Kajian Literatur

4.1 Kelemahan Kaedah Pelaporan Manual dalam Pendidikan

Kaedah pelaporan manual, seperti penggunaan buku log dan borang fizikal, sering kali menghadapi pelbagai kekangan. Antaranya termasuklah kesukaran dalam penyimpanan dan pengurusan data, risiko kehilangan maklumat, serta ketidakcekapan dalam proses penilaian dan maklum balas. Menurut kajian oleh Omar (2016), kelemahan dalam penulisan laporan projek termasuklah jalinan antara bab yang tidak sempurna, idea yang tidak matang, dan kekurangan data yang relevan untuk menguji hipotesis. Situasi ini menunjukkan perlunya transformasi dalam kaedah pelaporan projek pelajar ke arah sistem yang lebih efisien dan bersepadu

4.2 Penggunaan Aplikasi Mudah Alih dalam Pendidikan

Perkembangan pesat teknologi mudah alih telah membuka peluang baharu dalam bidang pendidikan. Aplikasi mudah alih menawarkan fleksibiliti, kemudahan akses, dan interaktiviti yang tinggi, menjadikannya alat yang berkesan dalam menyokong proses pengajaran dan pembelajaran. Kajian oleh Nawi (2017) menekankan bahawa penggunaan aplikasi mudah alih dalam pendidikan dapat meningkatkan motivasi pelajar untuk belajar secara kendiri dan memperkasa pembelajaran sepanjang hayat. Selain itu, penggunaan aplikasi mudah alih juga membolehkan penyesuaian kandungan pembelajaran mengikut keperluan individu pelajar, seterusnya meningkatkan keberkesanan pembelajaran.
Penggunaan peranti mudah alih dalam pembelajaran telah terbukti meningkatkan penglibatan dan motivasi pelajar. Guerrero et al. (2024) mendapati bahawa penggunaan alat seperti Socrative dan aplikasi lain meningkatkan penyertaan pelajar dalam pembelajaran kelas teori dan praktikal. Selain itu, kajian oleh Awedh et al. (2015) menunjukkan bahawa penggunaan Socrative melalui telefon pintar menyokong pembelajaran kolaboratif dan mempertingkatkan prestasi akademik pelajar.

4.3 Integrasi Teknologi dan Kurikulum dalam Pendidikan

Integrasi teknologi dalam kurikulum pendidikan merupakan langkah penting dalam memastikan kandungan pengajaran sentiasa relevan dan selari dengan perkembangan semasa. Fathurrahman et al. (2024) menyatakan bahawa penggabungan teknologi dalam kurikulum dapat memperkaya pengalaman pembelajaran pelajar serta meningkatkan kemahiran abad ke-21 seperti pemikiran kritis, kreativiti, dan literasi digital. Namun, cabaran seperti kekurangan latihan dan kemahiran teknikal dalam kalangan pendidik perlu diatasi untuk memastikan

integrasi teknologi yang berkesan dalam pengajaran dan pembelajaran. Seiring dengan itu, kajian oleh Ab Karim & Mustapha (2023) di Malaysia mendapati pelajar universiti memiliki persepsi dan penerimaan positif terhadap pembelajaran mudah alih semasa pandemik Covid-19, menunjukkan relevansi tinggi penggunaan aplikasi mudah alih dalam persekitaran pengajian tinggi.

Walaupun terdapat pelbagai aplikasi pembelajaran dan pengurusan kelas seperti Google Classroom, Microsoft Teams, dan Moodle, aplikasi-aplikasi ini secara amnya memberi tumpuan kepada penyampaian tugasan, bahan pembelajaran dan komunikasi, dan bukan direka bentuk khusus untuk menyokong pelaporan projek berasaskan minggu atau pemantauan perkembangan pelajar yang berasaskan rubrik dan silibus teknikal. Misalnya, Google Classroom tidak menyusun laporan berdasarkan fasa perkembangan projek dan tidak menyediakan padanan langsung dengan kandungan kurikulum (Iftakhar, 2016), manakala Microsoft Teams memerlukan konfigurasi tambahan untuk membolehkan penilaian progresif yang sistematik (Rathod et al., 2021). Moodle pula lebih sesuai untuk pembelajaran teori dan latihan kendiri berasaskan modul, tetapi kurang efisien dalam pemantauan projek praktikal berasaskan masa nyata (Al-Ajlan, 2012).

Berbeza dengan itu, pembangunan aplikasi eReport V2.0 bukan sahaja mengambil kira keperluan pelaporan mingguan pelajar, malah disepadukan secara langsung dengan struktur kurikulum seperti capaian kepada silibus rasmi, nota pengajaran terkini, penilaian formatif mingguan, serta rujukan video yang selari dengan hasil pembelajaran kursus (CLO). Pendekatan ini lebih menyeluruh dan bersifat khusus untuk subjek projek dalam program vokasional dan teknikal.

Maka, kewujudan eReport V2.0 bukan hanya sebagai alternatif kepada sistem pelaporan sedia ada, malah berperanan sebagai platform pembelajaran bersepadu yang mampu menyokong aspirasi pelaksanaan kurikulum berteraskan teknologi, sejajar dengan kehendak pendidikan abad ke-21.

5.0 Metodologi Kajian

Kajian ini dijalankan menggunakan kaedah kuantitatif melalui edaran soal selidik, sejajar dengan cadangan Creswell dan Creswell (2018) untuk reka bentuk penyelidikan kuantitatif. Seramai **65 orang responden** yang terdiri daripada **32 orang pelajar Semester 3 Sesi I 2023/2024, 25 orang pelajar Semester 3 Sesi II 2022/2023** dan **8 orang pensyarah** program **Sijil Teknologi Maklumat** telah terlibat dalam kajian ini. Soal selidik yang digunakan mengandungi **tiga bahagian utama**:

- **Bahagian A**: Maklumat Asas Responden
- **Bahagian B**: Pengalaman dan Kelemahan Kaedah Pelaporan Sedia Ada
- **Bahagian C**: Keperluan Sistem Baharu (eReport V2.0)

Setiap item dalam Bahagian B dan C dinilai menggunakan **Skala Likert lima mata** seperti berikut:

1 – Sangat Tidak Setuju
2 – Tidak Setuju
3 – Neutral

4 – Setuju
5 – Sangat Setuju

Penggunaan skala ini membolehkan pengkaji mengukur tahap persetujuan responden terhadap isu-isu yang dikemukakan secara kuantitatif. Data yang diperoleh dianalisis menggunakan kaedah peratusan bagi mengenal pasti kecenderungan umum dan keutamaan responden terhadap keperluan ciri-ciri dalam pembangunan sistem baharu.

5.1 Kajian Rintis

Sebelum soal selidik diedarkan kepada responden sebenar, satu kajian rintis telah dijalankan bagi menguji keberkesanan dan kesesuaian instrumen kajian. Kajian rintis ini melibatkan seramai 15 orang responden, iaitu 11 orang pelajar Semester 2 dan 4 orang pensyarah daripada program yang berlainan. Responden ini dipilih secara rawak dan tidak termasuk dalam sampel kajian sebenar bagi mengelakkan bias.

Tujuan utama kajian rintis adalah untuk memastikan bahawa item soal selidik yang dibangunkan adalah jelas, mudah difahami, dan menepati objektif kajian. Soal selidik telah diedarkan secara atas talian dan dijawab oleh responden secara individu. Hasil kajian rintis menunjukkan bahawa 90% responden menyatakan soalan adalah jelas dan mudah difahami. Ujian kebolehpercayaan soal selidik telah dijalankan menggunakan pekali Alpha Cronbach, dan hasil analisis menunjukkan nilai 0.82, melebihi ambang minimum 0.70 seperti yang disarankan oleh Nunnally dan Bernstein (1994), seperti dalam Jadual 1 dibawah. Ini menunjukkan bahawa item-item dalam instrumen tersebut mempunyai tahap konsistensi dalaman yang tinggi.

Jadual 1 Interpretasi Nilai Alpha Cronbach mengikut Nunnally dan Bernstein (1994)

Julat Nilai Alpha Cronbach	Interpretasi
< 0.60	Rendah (Tidak boleh diterima)
0.60 – 0.70	Sederhana
0.70 – 0.90	Tinggi (Diterima untuk kajian sosial)
> 0.90	Sangat Tinggi (Berpotensi item berlebihan atau berulang)

Secara keseluruhannya, hasil kajian rintis telah membantu memurnikan dan memperkukuhkan struktur soal selidik, seterusnya meningkatkan kualiti data yang diperoleh dalam kajian sebenar adalah sah dan boleh dipercayai.

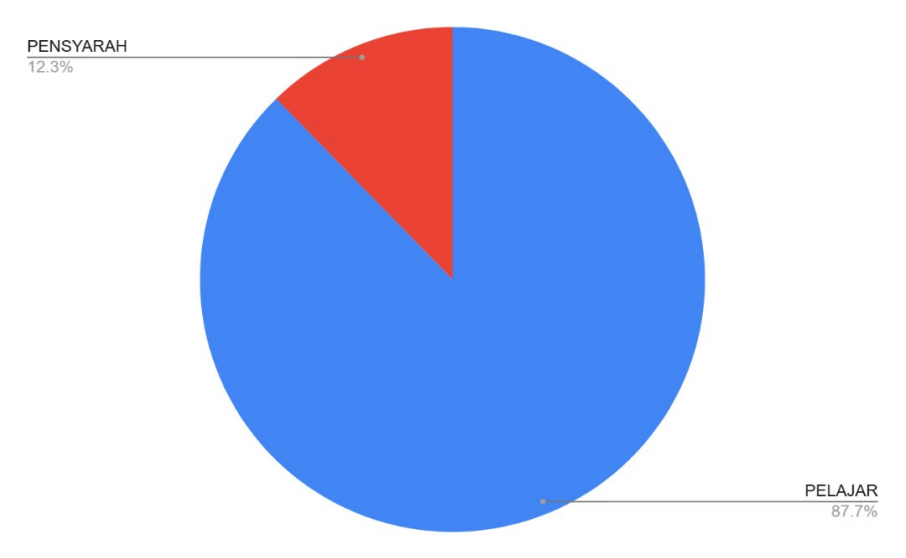
6.0 Dapatan dan Analisis Kajian

Data daripada 65 orang responden yang terdiri daripada 57 orang pelajar dan 8 orang pensyarah telah dianalisis menggunakan SPSS versi 27 melalui analisis deskriptif. Hasil dapatan dipersembahkan mengikut tiga bahagian utama iaitu Bahagian A (Maklumat Responden), Bahagian B (Pengalaman dan Kelemahan Kaedah Pelaporan Sedia Ada) dan Bahagian C (Keperluan Sistem Baharu – eReport V2.0).

6.1 Bahagian A: Maklumat Responden

- **Jumlah responden:** 65 orang

- Pensyarah: 8 orang
- Pelajar: 57 orang



Responden terdiri daripada 8 orang pensyarah dan 57 orang pelajar Semester 3, Sijil Teknologi Maklumat, Sesi I 2023/2024 dan Sesi II 2022/2023.

6.2 Bahagian B: Pengalaman dan Kelemahan Kaedah Sedia Ada

Tujuan Bahagian B adalah untuk mengenal pasti kelemahan pelaporan manual dan sistem Google Form yang digunakan sebelum ini. Jadual berikut menunjukkan nilai min, sisihan piawai, dan interpretasi tahap persetujuan berdasarkan skala Likert 5 mata.

Bil	Item Penyataan	Min (M)	Sisihan Piawai (SP)	Interpretasi
B1	Nota dan silibus yang tidak terkini	4.74	0.45	Sangat Setuju
B2	Penulisan buku log secara manual memerlukan masa yang lama	4.74	0.45	Sangat Setuju
B3	Buku log manual mudah rosak, hilang atau tidak lengkap	4.87	0.34	Sangat Setuju
B4	Google Form menyukarkan semakan semula laporan lalu	4.77	0.42	Sangat Setuju
B5	Antaramuka Google Form tidak mesra pengguna	4.65	0.48	Sangat Setuju
B6	Maklum balas pensyarah sukar difahami dan tidak disimpan	4.84	0.37	Sangat Setuju

Keseluruhan item Bahagian B memperoleh nilai min melebihi 4.60, menunjukkan tahap persetujuan yang sangat tinggi terhadap kelemahan sistem pelaporan manual dan Google Form. Nilai sisihan piawai rendah menunjukkan jawapan konsisten dan homogen dalam kalangan responden.

6.3 Bahagian C : Keperluan Sistem Baharu (eReport V2.0)

Bahagian C bertujuan untuk mengenal pasti keperluan utama yang dicadangkan untuk dimasukkan ke dalam pembangunan aplikasi eReport V2.0.

Bil	Item Penyataan	Min (M)	Sisihan Piawai (SP)	Interpretasi
C1	Sistem baharu perlu dibangunkan	5.00	0.00	Sangat Setuju
C2	Capaian kepada nota, silibus dan video terkini	5.00	0.00	Sangat Setuju
C3	Semakan log projek mingguan yang tersusun	5.00	0.00	Sangat Setuju
C4	Paparan komen pensyarah yang jelas	4.94	0.25	Sangat Setuju
C5	Notifikasi WhatsApp untuk pelaporan mingguan	4.87	0.34	Sangat Setuju
C6	Fungsi muat turun laporan penuh	4.94	0.25	Sangat Setuju
C7	Boleh diakses melalui telefon pintar/peranti lain	5.00	0.00	Sangat Setuju

Analisis data bagi Bahagian C menunjukkan bahawa semua item berkaitan keperluan terhadap sistem baharu mencatatkan nilai min yang sangat tinggi, iaitu antara 4.87 hingga 5.00, menunjukkan tahap persetujuan yang amat tinggi daripada responden. Empat item utama iaitu C1 – Sistem baharu perlu dibangunkan, C2 – Capaian kepada nota, silibus dan video terkini, C3 – Semakan log projek mingguan yang tersusun, dan C7 – Akses melalui telefon pintar/peranti lain mencatatkan min maksima 5.00 dan sisihan piawai 0.00.

Nilai sisihan piawai 0.00 ini menunjukkan bahawa semua responden memberikan skor yang sama (iaitu 5 – Sangat Setuju) terhadap item-item tersebut. Keadaan ini menggambarkan bahawa terdapat persetujuan sebulat suara atau konsensus penuh dalam kalangan responden bahawa ciri-ciri tersebut merupakan keperluan utama yang perlu dimasukkan ke dalam pembangunan sistem eReport V2.0. Dapatan ini mencerminkan kepentingan mutlak ciri-ciri berkenaan dalam konteks penyampaian kandungan kurikulum dan sokongan pembelajaran projek pelajar secara digital dan mudah diakses.

Ciri-ciri seperti capaian kepada bahan pengajaran terkini (nota, silibus dan video), pelaporan mingguan yang tersusun serta keupayaan untuk mengakses sistem melalui peranti mudah alih bukan sahaja dianggap sebagai kemudahan tambahan, malah telah menjadi satu keperluan asas dalam pembelajaran teknikal masa kini. Tambahan pula, keperluan untuk membangunkan sistem baharu turut menunjukkan bahawa pendekatan tradisional tidak lagi relevan sepenuhnya dalam memenuhi keperluan pembelajaran berasaskan projek dan pemantauan progres pelajar secara sistematik.

Dapatan ini memperkukuhkan rasional pembinaan eReport V2.0 sebagai platform pelaporan berstruktur dan pembelajaran bersepadu yang menyokong aspirasi pendidikan teknikal abad ke-21. Justeru, pembangun sistem perlu memberi keutamaan kepada ciri-ciri ini dalam reka bentuk antaramuka dan fungsi utama aplikasi agar ia benar-benar memenuhi keperluan pengguna akhir.

6.4 Analisis Inferensi: Ujian ANOVA Sehala berdasarkan Peranan Responden

Bagi menilai sama ada terdapat perbezaan signifikan dalam persepsi keperluan terhadap pembangunan sistem eReport V2.0 antara kumpulan pelajar dan pensyarah, satu analisis varians sehala (One-Way ANOVA) telah dijalankan. Pemboleh ubah bersandar dalam analisis ini ialah skor min keseluruhan Bahagian C (Keperluan Sistem Baharu), manakala pemboleh ubah bebas ialah peranan responden, iaitu sama ada sebagai pelajar atau pensyarah.

Hipotesis Kajian:

H0 (Hipotesis nol): Tiada perbezaan signifikan dalam skor min keperluan sistem baharu antara pelajar dan pensyarah.

H1 (Hipotesis alternatif): Terdapat perbezaan signifikan dalam skor min keperluan sistem baharu antara pelajar dan pensyarah.

Hasil Ujian ANOVA:

Sumber Varians	Jumlah Kuasa Dua (SS)	Darjah Kebebasan (df)	Min Kuasa Dua (MS)	Nilai F	Signifikan (p)
Antara Kumpulan	0.072	1	0.072	1.823	0.182
Dalam Kumpulan	2.442	63	0.039		
Jumlah (Total)	2.514	64			

$F(1, 63) = 1.823$, $p = 0.182$

Interpretasi Dapatan:

Nilai p yang diperoleh adalah 0.182, iaitu melebihi aras signifikan yang ditetapkan ($\alpha = 0.05$). Ini menunjukkan bahawa tiada perbezaan yang signifikan dalam persepsi terhadap keperluan sistem baharu antara kumpulan pelajar dan pensyarah.

Dapatan ini membuktikan bahawa keperluan terhadap pembangunan sistem eReport V2.0 dikongsi secara menyeluruh dan konsisten oleh kedua-dua kumpulan utama pengguna, tanpa mengira peranan mereka dalam proses pengajaran dan pembelajaran. Oleh itu, sistem yang akan dibangunkan perlu mengambil kira ciri-ciri yang menyokong keperluan semua pengguna tanpa diskriminasi terhadap latar belakang mereka.

7.0 Perbincangan dan Keputusan

Hasil kajian menunjukkan bahawa pelajar dan pensyarah menghadapi pelbagai cabaran dengan sistem pelaporan sedia ada. Majoriti responden sangat bersetuju terhadap keperluan pembangunan sistem yang baharu, lebih sistematik dan mudah diakses. Sistem sedia ada seperti buku log manual dan Google Form dilihat tidak memenuhi keperluan pelaporan dan pembelajaran yang interaktif, tersusun dan fleksibel. Pensyarah juga memerlukan satu platform bersepadu untuk memberi maklum balas dan menilai pelaporan pelajar secara konsisten dan boleh dijejak.

Pembangunan aplikasi eReport V2.0 perlu mengambil kira beberapa ciri utama yang diutamakan responden, iaitu paparan mesra pengguna dan interaktif, integrasi bahan pembelajaran mengikut kurikulum, simpanan dan capaian laporan secara atas talian, fungsi komunikasi maklum balas secara jelas dan teratur, serta capaian pelbagai peranti dan

pemberitahuan secara terus.Modul capaian kepada silibus, nota, rujukan video dan penilaian berasaskan kurikulum terkini amat diperlukan oleh pelajar (Norazah & Zurina, 2017). Tambahan pula, sistem ini juga diharap dapat menyokong strategi pembelajaran fleksibel dan kendiri (Ally, 2009).

Selain itu, satu keperluan utama yang juga dikenalpasti ialah pembangunan modul pembelajaran dalam aplikasi, yang mengandungi c**apaian kepada silibus dan nota terkini** berdasarkan kurikulum semasa, b**ahan rujukan berbentuk video interaktif dan modul penilaian untuk mudah dicapai oleh pelajar.** Modul ini bukan sahaja menyokong pembelajaran kendiri pelajar, tetapi juga membolehkan pensyarah menyelaras bahan pembelajaran dan pemantauan dengan lebih berkesan.

Seterusnya, analisis inferensi menggunakan Ujian ANOVA Sehala turut dilaksanakan bagi mengenal pasti sama ada terdapat perbezaan signifikan antara pelajar dan pensyarah terhadap skor min keperluan sistem baharu. Keputusan menunjukkan bahawa nilai $F(1, 63) = 1.823$ dengan $p = 0.182$, iaitu melebihi aras signifikan $p < 0.05$. Ini menunjukkan bahawa tiada perbezaan signifikan antara kumpulan pelajar dan pensyarah, sekaligus memperkukuhkan dapatan bahawa keperluan terhadap pembangunan eReport V2.0 adalah sejagat dan dikongsi secara menyeluruh oleh semua kumpulan pengguna.

Hasil ini memberi justifikasi kukuh bahawa pembangunan sistem pelaporan dan pembelajaran baharu ini perlu direka bentuk secara menyeluruh dengan memenuhi keperluan kedua-dua pihak: pensyarah sebagai penyelaras dan penilai, serta pelajar sebagai pengguna utama yang perlu menyempurnakan pelaporan dan akses pembelajaran secara fleksibel, interaktif dan konsisten.

8.0 Cadangan

Berdasarkan dapatan kajian dan analisis keperluan pengguna, adalah dicadangkan agar pembangunan aplikasi eReport V2.0 merangkumi dua komponen utama yang saling melengkapi, iaitu Modul Pembelajaran dan Sumber serta Modul Pelaporan Projek.

Modul Pembelajaran dan Sumber berperanan menyediakan akses kepada kandungan pembelajaran yang lengkap dan selari dengan kurikulum semasa. Modul ini harus merangkumi silibus dan nota terkini berdasarkan sukatan rasmi, pautan kepada video pembelajaran yang relevan, serta penilaian berterusan (*continuous assessment*) yang boleh dicapai oleh pelajar secara terus dalam aplikasi. Modul ini perlu direka bentuk supaya mesra peranti mudah alih, dan boleh diakses melalui telefon pintar, tablet serta komputer, bagi menyokong pembelajaran fleksibel dan kendiri.

Manakala Modul Pelaporan Projek pula dicadangkan untuk menambah baik proses pemantauan dan penilaian projek pelajar. Modul ini perlu menyokong pelaporan log projek secara harian atau mingguan dalam susunan kronologikal, memaparkan komen dan maklum balas pensyarah secara langsung dalam satu paparan, serta menyediakan sistem notifikasi mingguan untuk mengingatkan pelajar tentang tugasan yang belum dihantar. Di samping itu, fungsi muat turun laporan akhir dalam bentuk dokumen juga dicadangkan bagi memudahkan proses dokumentasi dan penilaian akhir.

Secara keseluruhannya, kedua-dua modul ini akan menjadikan eReport V2.0 sebagai satu platform pelaporan dan pembelajaran bersepadu, yang bukan sahaja mesra pengguna, tetapi turut menyokong keberkesanan pedagogi digital dalam pendidikan teknikal dan vokasional.

9.0 Kesimpulan

Kajian ini membuktikan keperluan kritikal untuk membangunkan aplikasi eReport V2.0 yang bukan sahaja menambah baik proses pelaporan projek, tetapi juga menyokong pembelajaran melalui satu modul aplikasi yang komprehensif dan mesra pengguna. Pembangunan sistem ini diharapkan dapat menyumbang kepada peningkatan kualiti pengajaran dan pembelajaran di Kolej Komuniti, khususnya Kolej Komuniti Pasir Gudang.

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Business Analysis Of Jellyfish-Based Product Innovation

Nur Istiqamah[1*], Nur Astri Fatihah[2],

[1,2,]Department of Agribusiness, Politeknik Negeri Sambas, Jalan Raya Sejangkung Sambas Kalimantan Barat Indonesia

* email: inonkistiqamah@gmail.com, nafatihah@gmail.com

Abstract

Jellyfish have the potential to be used as raw materials in production and have high marketing prospects. According to data from the National Border Management Agency of the Republic of Indonesia (BNPP RI), the value of jellyfish exports through the Aruk Border Crossing Point in February 2024 was 4,800 kg, worth Rp.59,520,000 . This study aims to analyze the potential of jellyfish crackers as a future business venture. This study uses profit analysis as its method. The jellyfish cracker production calculation results show a total cost of Rp. 2,851,667 and revenue of Rp. 7,875,000, resulting in a net profit of Rp. 5,023,333. Based on these calculations, the jellyfish cracker business is feasible for further development. It is declared efficient based on an Revenue Cost Ratio of 2.76, a production Break Even Point (BEP) of 114 packs, and Break Even Price of Rp 9,053.

Keywords: *Innovation, Profit, Jellyfish*

1. Introduction

The fisheries sector holds a crucial and influential position in enhancing the standard of living and overall well-being of the people of Indonesia, as it significantly contributes to their economic stability, food security, and social development. The development of fisheries in Indonesia aims to increase the income and welfare of fishermen and the value of exports (Arrazaq, M., et al., 2020)

Jellyfish is a commodity that can be used for food and medicine. Chinese people have eaten jellyfish for thousands of years, so the jellyfish fishing industry for food is quite developed in East Asia, including Japan. The traditional jellyfish processing method is still used in the industry, albeit with various modifications. The process of preparing jellyfish for consumption is simple and has low production costs, but it requires intensive labor (Hsieh et al., 2001).

According to Istiqamah (2021), jellyfish processing in the Paloh subdistrict is generally seasonal and only a side job. This is because processing is only carried out during certain seasons, once every one to four years.

Most of the jellyfish caught by fishermen in Paloh are exported to Malaysia because Paloh District borders Malaysia. According to data from the National Border Management Agency of the Republic of Indonesia (BNPP RI), the value of jellyfish exports through the Aruk border crossing was recorded at 4,800 kilograms in February 2024, worth Rp59,520,000.

Given the potential of raw materials and marketing prospects, Jellyfish's processed product innovation is an alternative business that can be developed in the future. However, before it can be developed, the product innovation must be analyzed to ensure it will benefit business actors.

2. Literature Review

2.1 Jellyfish

The Aurelia aurita, or jellyfish, is one of the simplest marine or aquatic animals. They have no brain, bones, lungs, or intestines. Some people consider this animal to be a harmful stinging organism. Additionally, jellyfish are considered pests by fishermen because they affect their catch (Wahyuningsih et al., 2022).

Chinese people have eaten jellyfish for thousands of years, so today, the jellyfish fishing industry for food is quite developed in East Asia, including Japan. The traditional process of preparing jellyfish remains a model for the industry, albeit with various modifications. The process of preparing jellyfish for consumption is simple and inexpensive, but it requires intensive labor (Hsieh et al., 2001).

2.2 Feasibility Study

According to Jakfar and Khasmir (2003), a feasibility study should be conducted and assessed through predetermined stages correctly and precisely. Each stage has various aspects that must be researched, measured, and assessed according to the predetermined provisions.

To assess the feasibility of a business, several interconnected aspects must be thoroughly examined. These include the legal framework, market and marketing strategies, financial health and viability, technical and operational capabilities, management and organizational structure, social and economic factors, as well as the potential environmental impacts of the business. Each of these factors plays a pivotal role in determining whether the business can succeed and sustain itself in the long term.

According to Jakfar and Khasmir (2003), a business feasibility analysis must be carried out for five reasons:

1. Facilitate planning
2. Facilitate the implementation of work
3. Avoiding the risk of loss
4. Facilitate supervision
5. Facilitate control

According to Arsasi (2009), the stages of feasibility analysis include:

1. Identification stage
2. Pre-selection stage
3. Analysis stage

Jakfar and Khasmir (2003) state that the assessment of financial aspects includes the following:

1. Sources of funds to be obtained
2. Investment cost requirements
3. Estimated investment income and costs over several periods including the types and amount of costs incurred during the investment life
4. Projected balance sheet and profit/loss statement for the next few periods
5. Criteria for investment appraisal
6. Financial ratios used to assess the company's ability

3. Methods

The primary data in this study, such as production and cost data, were obtained through experiments in making jellyfish crackers conducted at the Fisheries and Marine Agribusiness Laboratory of the Politeknik Negeri Sambas. Meanwhile, the secondary data in this study were obtained from literature and sources from agencies related to jellyfish production and other data that supported the research objectives.

The term "jellyfish" is commonly used to describe the medusa stage of marine organisms within the subphylum Medusozoa of the phylum Cnidaria (also known as Coelenterata). In some cultures, certain species of the scyphozoan class, particularly those in the order Rhizostomeae, are harvested for food. A distinguishing characteristic of jellyfish is their bell-shaped, umbrella-like structure, which is known as the mesoglea. This structure acts as the hydrostatic skeleton for these invertebrates (Kui et al., 2007). The hood is characterized by long, suspended tentacles covered with cnidocytes, which are venomous cells unique to the phylum Cnidaria (Lim, 1992).

The majority of jellyfish caught are primarily used as food for humans, while in certain situations, they are harvested to be removed from areas where they pose a threat to tourism or other industries. Research on jellyfish has provided valuable insights into areas such as vision (Nilsson et al., 2005) and has contributed to two Nobel Prizes: one awarded in 1913 for the discovery of anaphylaxis, and another in 2008 for the development of fluorescent proteins. Beyond scientific research, jellyfish have inspired innovations in design engineering, with their simple yet efficient biomechanics being mimicked in various fields (Dabiri, 2011; Najem et al., 2012; Ristroph & Childress, 2014; Costello et al., 2015; Gemmell et al., 2013; 2015). Their unique characteristics are also being explored in diverse applications such as agriculture, materials science, and pharmaceuticals, highlighting the growing interest in jellyfish as a source of inspiration for a wide range of industries.

According to Soekartawi (2006), production costs are the sum of fixed and variable costs.

a. Cost Analysis
   TC= TFC+TVC
   TC : Total Cost (Rp/ month)
   TFC : Total Fixed Cost (Rp/ month)
   TVC : Total Variable Cost (Rp/ month)

b. Revenue Analysis
   TR = P x Q
   TR Total Revenue (Rp/ month)
   P : price (Rp/kg)
   Q : quantity (Kg/onth)

c. Net Profit
   π = TR- TC
   π : net profit (Rp/month).
   TR : Total Revenue
   TC : Total Cost

d. Revenue Cost Ratio

$$\textbf{R/C Ratio} = \frac{TR}{TC}$$

TR : Total Revenue (Rp)
TC : Total Cost (Rp)

e. Break Even Point

$$\textbf{Production Break Even Point (BEP)} = \frac{TC}{P}$$

TC : Total Cost (Rp)
P : Price (Rp)

$$\textbf{Break Even Price (BEP)} = \frac{TC}{Q}$$

TC : Total Cost (Rp)
Q : Quantity

4. Result

Jellyfish crackers were invented because no similar product existed. Considering the physical nature of jellyfish, which melt easily when heated, it was difficult to process them into dry food products.

The production of jellyfish crackers begins with the preparation of the main raw material, which is the drained jellyfish. Draining is a crucial step that reduces the water content in the jellyfish, and it occurs after the salting process. Once the jellyfish are salted, they are typically packed in special packaging to preserve their quality. At this stage, the jellyfish are ready to be marketed for further processing into products like jellyfish crackers.



Figure. 1. Jellyfish Drining Process

Before being used in culinary preparations, the jellyfish are soaked in fresh water for approximately 12 hours. Then, they are boiled in boiling water for about two minutes. Boiling them for too long will cause them to melt, turning the entire body into liquid.



Figure. 2. Jellyfish Boiling Process

The boiled jellyfish is blended until smooth, then mixed into the dough used to make jellyfish crackers.



Figure. 3. Results of Crackers Experiment

The image above shows the results of the jellyfish cracker experiment. The small particles in the crackers are finely ground jellyfish meat mixed with the other ingredients used to make crackers.

4.1 Production Cost Analysis

The cost of processing cracker products for one month consists of seven production processes and includes both fixed and variable costs. Fixed costs remain constant throughout the production process of jellyfish crackers. Variable costs, meanwhile, are costs that fluctuate during the production process.

Table 1. Equipment Depreciation Costs

Tools	Price (Rp)	Service Life (Year)	Residual Value (Rp)	Depreciation cost (Rp)
Oven	650.000	3	283.499	122.167
Teflon	50.000	4	20.000	7.500
Blender	250.000	3	75.000	58.333
Pot	30.000	3	15.000	5.000
Basin	10.000	1	4.500	5.500
Metal Spatula	25.000	2	10.000	7.500
Spoon	3.000	2	1.667	667
Loaf pan	50.000	3	30.000	6.667
Plastic Sealer	200.000	3	172.000	9.333
Total				222.667

Table 2. Fixed costs

Tools	Price (Rp)
Oven	650.000
Teflon	50.000
Blender	250.000
Pot	30.000
Basin	10.000
Metal Spatula	25.000
Spoon	3.000
Loaf pan	50.000
Plastic Sealer	200.000
Employee Wages	700.000
Equipment depreciation	222.667
Total	2.190.667

Table 3. Variable costs

Material	Price (Rp)
Jellyfish	315.000
Wheat flour	45000
Tapioca	35.000
Cornstrach	42.000
Cooking oil	35.000
Mushroom seosening	56.000
Garlic powder	84.000
Egg	14.000
Packaging plastic	35.000
Total	661.000

Table 4. The Total Cost of Producing Jellyfish Crackers

Description	Amount (Rp)
Total Fixed costs (TFC)	2.190.667
Total Variable costs (TVC)	661.000
Total Cost (TC)	2.851.667

The total cost of producing jellyfish crackers is Rp. 2,851,667, with seven production runs per month.

4.2 Profit Analysis

Profit is calculated by subtracting total revenue from total costs in the production of jellyfish crackers, and the result is then divided by two to arrive at the desired profit margin.

Table 5. Total Revenue of Producing Jellyfish Crackers

Description	Amount (Rp)
Price (P)	25.000
Quantity (Q)	315
Total Revenue (TR)	7.875.000

Table 6. Net Profit of Producing Jellyfish Crackers

Description	Amount (Rp)
Total Revenue (TR)	7.875.000
Total Cost (TC)	2.851.667
Net Profit (π)	5.023.333

The total revenue from jellyfish cracker sales was Rp. 7,875,000, and the net profit from the business was Rp. 5,023,333.

a. Revenue cost ratio (R/C Ratio)

The revenue cost ratio (R/C ratio) is the value obtained by comparing total revenue and total costs of jellyfish crackers.

Table 7. Revenue Cost Ratio of Producing Jellyfish Crackers

Description	Amount (Rp)
Total Revenue (TR)	7.875.000
Total Cost (TC)	2.851.667
R/C Ratio	2,76

Table 6 shows that the revenue cost ratio (R/C ratio) for jellyfish cracker production is 2,76, indicating that this business is efficient. For every Rp. 1,00 spent, Rp. 2,76 in revenue per production process.

b. Break Event Point

Table 8 Production Break Even Point (BEP)

Description	Amount (Rp)
Total Cost (TC)	2.851.667
Price (P)	25.000
Production Break Even Point	114,06

Tabel 9. Break Even Price (BEP)

Description	Amount (Rp)
Total Cost (TC)	2.851.667
Quantity (Q)	315
Break Even Price	9.052,9

The results show that every 1kg of jellyfish produces 45 packets of crackers, so seven production runs per month can yield 315 packets of crackers. The selling price of the crackers is assumed to be Rp.25.000 per packet, given that the product is made from ingredients that are difficult to obtain and rarely found on the market.

The break-even point (BEP) is when a business neither makes a profit nor incurs a loss. The production break even point for jellyfish crackers is 114 packets. If production exceeds this number, the business will generate a profit. The break even price calculation results in Rp 9,053, which is less than the selling price of Rp 25,000 per packet. This makes the business efficient.

5. Conclusion

The results of jellyfish-based innovation research show that:

a. The calculations for producing jellyfish crackers show a total cost of Rp. 2,851,667 and revenue of Rp. 7,875,000. This results in a net profit of Rp. 5,023,333. Based on these results, the jellyfish cracker business is feasible for further development.
b. The jellyfish cracker business is considered efficient. It has an R/C ratio of 2.76. Its production break-even point is 114 packs. Its break-even price is Rp. 9,053.

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Barriers to the Implementation of Green Practices: A Case Study of Medium-Sized Hotels in Melaka, Malaysia

Salfarina Abdul Sukor [1], Rumizi Abdul Manaf [2], Abdul Razak bin Wari[3]

[1,2,3 3]Kolej Komuniti Bukit Beruang, 23, Jalan Bukit Beruang Indah 1, Taman Bukit Beruang Indah, 75450 Bukit Beruang, Melaka

*salfarina@kkbbm.edu.my, rumizi@kkbbm.edu.my, abdulrazak@kkbbm.edu.my

Abstract

Sustainable practices have become a central concern in the global hospitality sector, and understanding the barriers to their adoption is critical for advancing greener tourism development. In Melaka, Malaysia, medium-sized hotels are important contributors to the city's tourism economy but continue to face obstacles in implementing environmentally responsible initiatives. This study aims to explore the key barriers encountered by these hotels in adopting green practices. A qualitative approach was employed, using semi-structured interviews with eight key respondents, comprising hotel managers and department heads directly involved in sustainability-related operations. The data were analysed thematically with the support of qualitative analysis software to identify recurrent verse. The findings revealed four major barriers: financial and budgetary constraints, operational disruptions linked to sustainable measures, shortages of trained staff, and limited space for green facilities. These barriers have slowed the effective adoption of sustainability initiatives, despite increasing awareness of their importance. The study concludes that enhanced policy support, industry-specific training, and collaborative strategies are needed to strengthen the capacity of medium-sized hotels to embrace sustainable practices. By situating Melaka as a case study, the research contributes to broader discussions on sustainability in tourism-driven destinations while offering practical insights for the hospitality industry.

Keywords: *Green practices, Medium-sized hotels, Sustainability barriers, Hospitality industry, Melaka tourism*

1. Introduction

Tourism and hospitality are widely recognized as key drivers of economic growth. They generate employment, create income, and encourage cultural exchange. Yet, these benefits often come with environmental costs. The hotel sector, in particular, consumes large amounts of energy and water while producing significant waste. This dual role had supporting growth while straining the environment that has pushed sustainability to the forefront of global discussions on hospitality.

In response, many hotels worldwide have begun adopting green practices. These range from energy-saving and water conservation systems to waste management programs and participation in eco-certification schemes. Such initiatives are no longer viewed only as environmental necessities. They are increasingly understood as business strategies that enhance competitiveness, attract environmentally aware guests, and strengthen brand reputation (Reem et al., 2022; Baum, 2019). However, uptake is far from uniform. The extent of adoption varies across hotel types and locations, showing that despite the recognized importance of sustainability, significant barriers to implementation remain. Therefore, the need for practices that sustain operations, and nature is driven by environmental issues, such as resource depletion and climate change (Elkhwesky et al., 2022).

Malaysia has been proactive in advancing sustainability in tourism using the national development strategies that have focused on low-carbon development and environmental management, such as the Eleventh and Twelfth Malaysia Plans. At the core of these objectives is the hospitality industry, which has a role to play in achieving the positioning of Malaysia as

a competitive and sustainable tourism destination (Reem et al, 2020). It has been noted, though, that, although there is a great awareness and willingness of many Malaysian hotels to implement sustainability measures, the implementation level is not consistent (Han and Hyung 2020; Mokhtar, 2024). This is particularly evident in the case of small and medium-sized hotels that are usually not provided with the financial and institutional resources of large chains. Nevertheless, previous research has mostly focused on large hotel chains with more resources and established policies (Scholz et al., 2024). Because small and independent hotels frequently lack structured sustainability policies and have limited resources, there is a knowledge gap regarding how they handle environmental management practices due to the emphasis on large hotel groups. Despite facing particular difficulties, these small and medium-sized hotels are not well-represented in the literature currently in publication. According to Ahmed et al., 2020 almost 70% of Malaysia's hotel industry is made up of small and medium-sized establishments. Despite their widespread use, big hotel chains have received the majority of attention in research on operational procedures and sustainability. As a result, limited understanding about the small and medium-sized hotels handles issues like resource limitations, enforcing policies, and environmental standards. Since small and medium-sized hotels are essential in determining the overall sustainability performance of Malaysia's hotel industry, closing this gap is imperative.

Melaka is an especially prominent case study in that matter. UNESCO World Heritage City and one of the most tourism destinations in Malaysia, the economy of Melaka is tourism-based, and middle-sized hotels are at the centre of receiving tourists. The challenges that these hotels are facing are different: the constraints of heritage buildings, limited financing, lack of space, and the inability to recruit trained staff to carry out sustainability-relevant tasks. Although the literature has reported the financial, operational, and human resource hurdles to green practices (Baum, 2019; Khatter, 2023), the study of how these challenges is experienced in small medium-sized hotels in heritage cities such as Melaka has not been conducted. In Melaka, only 23 out of 394 hotels are rated four or five stars, while the remaining 371 are three-star or below, largely comprising small and medium-sized hotels (MOTAC, 2024). This suggests that small and medium-sized hotels play a significant role in Melaka's hospitality industry. However, despite their prevalence, previous research frequently ignores the sustainability issues and procedures of these businesses in favour of concentrating on big hotel chains. Consequently, there is still a great deal to learn about how small medium-sized hotels support and challenge sustainable tourism in Malaysia.

This paper fills this gap because it will examine obstacles faced by medium-sized hotels in implementing sustainable practices in Melaka. The study intends to give a finer comprehension of the barriers to sustainability adoption by using qualitative methods and suggestions by hotel managers and department heads. Thus, it not only serves a theoretical purpose in placing Melaka in a wider context of sustainable hospitality, but also a practical one, as its insights can be used in policy intervention and industry solutions.

2. Literature Review

2.1 Sustainable Practice in Hotel Industry

Sustainability in the hospitality industry has gained significant attention over the past two decades, as the environmental impacts of hotels have become more visible. Practices such as energy efficiency programs, waste minimization, recycling, and green certifications are increasingly recognized as essential components of responsible hotel management (Reem, et

al., 2022). Beyond ecological benefits, these initiatives are associated with enhanced brand reputation, improved customer satisfaction, and long-term cost savings (Yadav et., al, 2019). However, while global literature highlights numerous examples of best practices, the degree of implementation varies considerably across countries and hotel segments.

In the Malaysian context, national policies have emphasized sustainable tourism as part of broader development strategies. Yet, studies show that the adoption of green practices among local hotels is uneven. Larger and luxury hotels are generally more proactive, often due to better financial capacity, stronger brand visibility, and international affiliations. In contrast, small and medium-sized hotels tend to lag behind, citing limited resources and institutional support (Mokhtar, 2024; Hamzah et al, 2020). This national pattern is also evident in Melaka, which aspires to become a Green City (Perbadanan Teknologi Hijau Melaka, 2024). Little is known about how medium-sized hotels are reacting to these efforts. This disparity is critical because, although small medium-sized hotels make up the majority of hotels in the state, insufficient information is known about how well they can comply with green city regulations. It is impossible to evaluate the success of Melaka's sustainability agenda in the hospitality industry without knowing their role. This discrepancy underscores the importance of investigating specific barriers faced by different categories of hotels.

2.2 Related Theories and Model (Triple Bottom Line - TBL) Framework

The Triple Bottom Line (TBL) framework, first proposed by Elkington (1998), highlights sustainability through the interconnected dimensions of economic, environmental, and social outcomes (Refer to Fig. 1). It argues that organizational success should be assessed not only in terms of profitability but also by contributions toward environmental stewardship and social responsibility (Henriques & Richardson, 2013). Recent scholarship suggests that the application of TBL can serve as an effective strategy to strengthen long-term sustainability in the hospitality industry, particularly within smaller urban settings (Penaflor, 2025). Within this research, the framework is employed as a theoretical foundation to explore how medium-sized hotels in Melaka, a heritage city, integrate and operationalize green practices. Examining the three pillars enables the study to uncover the underlying motivations, the barriers faced, and the tangible impacts of sustainability adoption in this sector.

2.3 Barriers to the Adoption of Green Practices

Past research shows that hotels often face recurring challenges when trying to adopt sustainable practices. The most common barrier is financial. Setting up energy-efficient systems, waste management facilities, or eco-certification requires a large upfront investment (Khatter, 2023). For medium-sized hotels, which usually work on tight margins, the expected returns often look too small to justify the expense.

Challenges are not only financial. Green practices can interrupt daily operations or call for changes to existing infrastructure. In a heritage city like Melaka, modifying older buildings is even more complicated due to preservation rules (Baum, 2019). A lack of trained staff and limited managerial knowledge in sustainability make matters worse (Yadav et al., 2019). Weak policy enforcement and few incentives from the government also mean that hotel operators have less motivation to focus on sustainability (Reem et al., 2022).

Although global studies provide useful insights into these barriers, research in Malaysia—especially on medium-sized hotels—is still limited. Most studies concentrate on luxury hotels

or large urban chains, leaving heritage cities like Melaka overlooked. Since Melaka depends heavily on tourism and is a UNESCO World Heritage City, this gap deserves attention. This study responds to that need by exploring how medium-sized hotels in Melaka actually experience the process of implementing green practices.

3. Methodology

In order to explore the key barriers encountered by these hotels in adopting green practices, this study uses a qualitative research methodology. The research design, sampling strategy, tools, data collection, and data analysis techniques are all described in the methodology.

Meanwhile, observations protocol was conducted over five weeks systematically arranged, focusing on energy efficient usage system including solar panels, water saving devices, waste management practices, and guest–staff interactions, following guidelines adapted. In ensuring consistency across sites, a field notes and an observation form were taken from structured checklist modified from earlier hospitality sustainability studies.

To enhance data trustworthiness, member-checking was further conducted by returning the transcribed and summarised data to be verified. Moreover, inter-coder reliability was established through independent coding checks by two researchers. The level of agreement between their coding was then compared, and consistency indicated that the coding subset was reliable. In order to support the study findings, quotes from respondents will be used to interpret and report these themes.

Additionally, ethical considerations were strictly adhered to during the entire research process. The goals of the study were explained to the participants, who were also guaranteed their voluntary participation, the confidentiality of their answers, and the freedom to discontinue participation at any moment. All information was safely kept and used only for scholarly research. With the participants' permission, all interviews were audio recorded.

3.1 Research Design

The research design used in this study is a qualitative one where the motivation of implementing green practices, the barriers of green practices implementation in the medium sized hotels in Melaka has been conducted. As the quantitative survey will not be able to capture all the contextual factors and operational realities that need in-depth insight into the managerial perspectives, a qualitative approach was selected (Creswell and Poth, 2018). The primary mode of data collection was conducted using semi-structured interviews which was complemented by on-site observation of sustainability efforts. This was quite the right design since the aim of the study was to gain insight into the lived experiences of hotel managers and not to test any hypotheses.

3.2 Sampling Strategy

Purposive sampling was applied to ensure that the selected participants were directly involved in the implementation of green practices within their hotels. The focus was on medium-sized establishments (50-200 rooms) in Melaka, as these hotels represent a significant

portion of the tourism industry but often operate with fewer resources compared to large chains (Chan, 2019; Mensah, 2020). A total of eight informants were recruited, consisting of hotel managers and departmental heads, such as housekeeping and operations. This number was deemed sufficient because data saturation was achieved, where additional interviews no longer revealed new themes (Merriam & Tisdell, 2016).

a. Data Collection

Data were collected between November 2024 and January 2025. Semi-structured face-to-face interviews were conducted at the hotel premises, lasting between 30 to 45 minutes each. The interviews were guided by a flexible set of questions focusing on three main areas: (i) motivations for adopting green practices, (ii) barriers encountered during implementation, and (iii) outcomes for hotel performance and reputation.

To streamline the interview procedure, a pilot interview was conducted on a housekeeping manager of Hotel Seri Costa, Melaka. The pilot assisted in making some questions more relevant and clearer, and they made them context-specific to industry practitioners (Yin, 2016). Each site also observed non-participants in order to enhance the validity of the findings. These were observations of observable practices like separation of waste, water-saving, application of lighting that is energy-efficient and involvement of staff in sustainability programmes. Observation was also an effective complement since it enabled the researcher to record practices that were not necessarily expressed during the interviews (Lincoln and Guba, 1985).

3.4 Data Analysis

The thematic coding was used to process the data collected, and it is a popular research approach in qualitative studies to determine a recurrent pattern of results found in interview transcripts and their meaning (Braun and Clarke, 2006). This was done through a process of familiarisation, coding, grouping of codes into broad themes and refining of themes relative to the study objectives (Creswell and Creswell, 2018). The researcher reviewed the themes to ensure their alignment with the study's objectives and data. To substantiate the findings, respondent quotations were incorporated in the interpretation and reporting of these themes. Data saturation was determined when no additional codes emerged after eight to ten interviews, with later interviews confirming thematic consistency and the adequacy of the sample size (Zaidi et al., 2025). NVivo software was utilized to facilitate data management and to assist with interview transcription. However, in order to ensure adequate contextual depth, the interpretation was primarily guided by the researcher. (Creswell and Creswell, 2018).

4. Results

4.1 Profile of Respondents

To better contextualize the findings, the demographic and professional background of respondents are presented in Table 1. All eight respondents hold managerial or assistant managerial positions directly linked to hotel operations, sustainability, and decision-making processes. Their professional experience ranges from 5 to 20 years, with current tenure in the studied hotels between 2 to 10 years. This diversity of roles provided a well-rounded perspective on the challenges of adopting green practices.

Triangulation between interviews and observation notes enhanced the credibility of the findings. In addition, strategies such as peer debriefing, reflexivity, and careful documentation of the analysis process were employed to ensure the trustworthiness of the research (Lincoln & Guba, 1985).

Table 1. Profiles of Respondents

No.	Respondent	Position	Overall Experience (Years)	Current Hotel Experience (Years)	Rooms and Facilities
1	Respondent 1	Sales and Marketing Manager	6	2	100 guestrooms, 3-F&B outlet, tanning pool, 4- meeting rooms, 1-ballroom, 1-library
2	Respondent 2	Assistant Housekeeping Manager	5	2	100 guestrooms, swimming pool, spa, 1-F&B outlet
3	Respondent 3	Hotel Manager	10	10	189 rooms, swimming pool, seminar rooms, ballroom, 2- F&B outlets
4	Respondent 4	Maintenance Assistant Manager	8	2	87 guestrooms, swimming pool,5-meeting rooms, 1-F&B outlet
5	Respondent 5	Assistant Executive Housekeeper	14	4	136 guestrooms, 1-F&B outlet, 10 -meeting rooms, EV charging, surau
6	Respondent 6	Training & HR Manager	17	9	66 guestrooms, spa, swimming pool, gym, 3- F&B outlets, 4-meeting rooms, 1-ballroom
7	Respondent 7	Assistant Maintenance Manager	8	2	90 guestrooms, 1-banquet hall, 3-F&B outlets
8	Respondent 8	Hotel Manager	20	8	99 guestrooms, swimming pool, 3-meeting rooms, 1- ballroom, 1-F&B outlet

The respondent profiles highlight that medium-sized hotels in Melaka are managed by experienced professionals who balance operational efficiency with growing sustainability demands.

4.2 Summary of Identified Barriers

Analysis of interview transcripts revealed four key barriers hindering the adoption of green practices in medium-sized hotels: financial and budgetary constraints, operational disruptions, shortages of trained staff, and limited space for green facilities. Table 2 presents a summarized with these themes, alongside the number of respondents who raised each issue.

Table 2. Barriers to Green Practices Identified by Respondents

Barrier	Description	No. of Respondents	Example Quotes
Financial & Budgetary Constraints	High costs of sustainable initiatives; bureaucratic delays in budget approvals	3 (Respondents 2, 4, 8)	*"Planting trees requires proper soil, piping, and operational costs." (Respondent2)*
Operational Disruptions	Sustainable measures conflicting with existing systems or guest comfort	3 (Respondents 4, 8)	*"Slow faucets put pressure on pipes." (Respondent 4)*
Shortages of Trained Staff	Limited manpower for waste management, composting, or green operations	1 (Respondents 8)	*"We only have one gardener, so we can't manage large-scale planting." (Respondent 8)*
Limited Space for Green Facilities	Inadequate space for recycling, storage, or green technology installation	4 (Respondents 1, 5, 6, 7)	*"We needed big space to store bottles for recycling." (Respondent 1)*

4.3 Thematic Findings

4.3.1 Financial and Budgetary Constraints

Respondents consistently highlighted financial limitations as the most significant barrier. Although managers recognize the long-term benefits of sustainability, immediate costs deter investment in renewable energy, organic products, and recycling programs. For example, Respondent 2 described the hidden costs of tree planting (soil, piping, and maintenance), while Respondent 4 emphasized the slow approval process from parent organizations. Respondent 8 noted that even simple practices like recycling soap required more manpower and time, further raising operational costs.

These findings align with prior studies indicating that hotels often prioritize financial survival over sustainability, especially in post-pandemic recovery phases (Chan et al., 2021; Elkhwesky et al., 2022). Financial incentives and government subsidies have been identified as critical enablers for green adoption in similar contexts (Mensah, 2006).

4.3.2 Operational Disruptions Linked to Sustainable Measures

Several respondents shared how sustainability practices disrupted daily hotel operations. For instance, Respondent 4 described how water-saving faucets placed pressure on old pipe systems, causing technical breakdowns. Composting food waste was avoided by some hotels due to unpleasant odors (Respondent 4). Similarly, Respondent 8 highlighted that motion sensors for lighting, while effective in homes, negatively affected the guest experience in hotels by creating an "unwelcoming" atmosphere.

This reflects wider industry concerns where sustainability initiatives, if not tailored, may conflict with guest comfort and service standards (Han & Hyun, 2018; Hsiao et al., 2022). Hotels must therefore balance environmental goals with operational feasibility.

4.3.3 Shortages of Trained Staff

Staff shortages were another recurring theme. Informant 8 explained the difficulty of adopting practices like composting and replacing plastics with glass bottles due to insufficient manpower. For example, their hotel only employed one gardener, limiting the ability to maintain large green areas. In contrast, larger hotels with higher staff-to-room ratios could better handle these programs.

This challenge is supported by Zhang et al. (2021), who noted that inadequate training and manpower prevent effective waste management in small and medium hotels. Similarly, Bohdanowicz (2019) emphasized that sustainability requires specialized training, yet hospitality employees often lack such expertise.

4.3.4 Limited Space for Green Facilities

Physical space constraints further complicated sustainability efforts. Respondent 1 highlighted difficulties in storing recyclable bottles until collection, while Respondent 5 noted the need for staff to flatten bottles due to limited storage. Respondent 6 described restrictions in providing EV charging points due to small basement parking areas. Such findings echo earlier research which found that older hotel infrastructures, especially in heritage cities, limit the integration of modern green technologies (Yusof & Jamaludin, 2018; Jones et al., 2022). This suggests that spatial limitations are particularly critical in dense urban contexts like Melaka.

4.4 Discussion

The results indicate that medium-sized hotels in Melaka encounter a range of difficulties in adopting green practices. Among these, financial limitations stand out as the primary obstacle, a finding that aligns with trends reported in international studies. Additional issues, such as operational interruptions, workforce shortages, and limited physical space, reflect the unique constraints faced by heritage cities with restricted infrastructure and resources.

Compared to larger hotels or international chains, medium-sized hotels lack both economies of scale and corporate resources, placing them at a disadvantage in sustainability adoption (Elkhwesky et al., 2022). Yet, their central role in Melaka's tourism economy means their struggles directly impact the city's ability to position itself as a green destination.

Theoretically, this study contributes to the body of research because of its emphasis on a sector that is widely ignored in the literature. The findings point towards the need for targeted policies, capacity-building programs, and collaborative initiatives to support hotels with limited resources in advancing sustainable tourism. It shows that a qualitative method is critical in revealing the subtle realities of hotel managers, as it is highlighted by Bindawas (2025) and Memarzadeh & Anand (2020). This paper focuses on middle-sized hotels by underlining the specific issues that they encounter as compared to large-sized or chain hotels particularly regarding heritage buildings and constrained resources.

These findings also extend the application of the Triple Bottom Line (TBL) framework in sustainable hospitality research (Refer to Fig. 1). While previous studies often emphasize large or international hotels, this study demonstrates that medium-sized hotels in heritage cities encounter distinct economic, environmental, and social constraints that are not fully captured in existing models. Economically, they face acute financial limitations and lack economies of scale; environmentally, space restrictions and outdated infrastructures constrain the integration of green technologies; and socially, staff shortages and limited guest cooperation hinder operationalization. By situating these barriers within the TBL framework, this study highlights that sustainability adoption is not only a matter of organizational choice but also shaped by contextual realities such as heritage conservation, urban density, and resource limitations. This suggests the need to refine existing frameworks to account for the experiences of medium-sized hotels, thereby broadening theoretical understandings of sustainable hospitality.

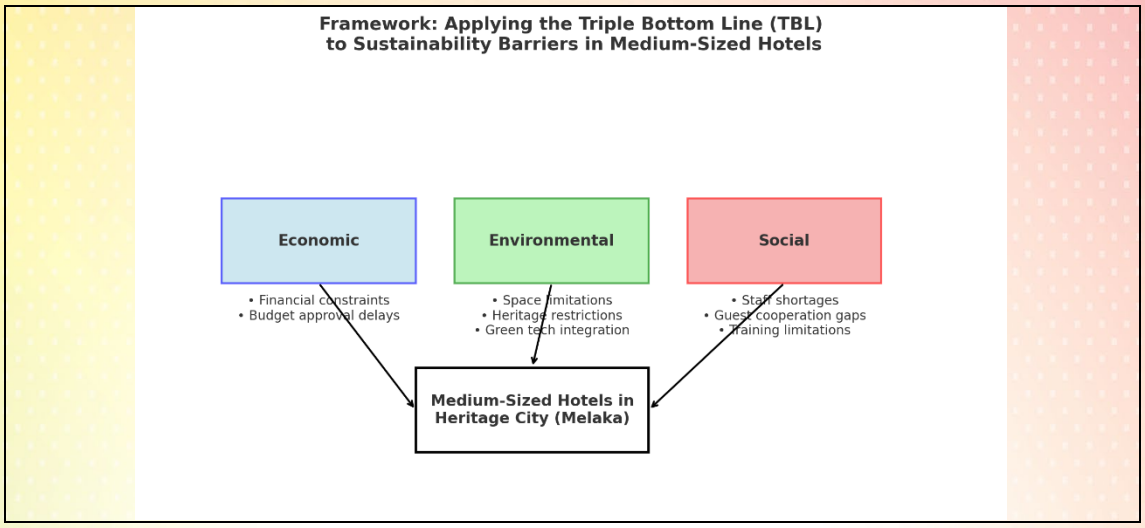


Fig. 1. *Application of the Triple Bottom Line (TBL) to Sustainability Barriers in Medium-Sized Hotels*

On the other hands, several practical implications can be proposed to support medium-sized hotels in advancing sustainability. These can be structured across short-term and long-term horizons, as well as at the industry and policy levels. Hotel owners and managers can adopt a phased approach to green investment in long-term. Hotels can begin with simple, low-cost measures such as LED lighting, digital communication, and basic water-saving systems before moving toward bigger investments like solar power or advanced water recovery (Han & Hyun, 2018; Hamzah et al., 2020). Staff development should be ongoing, supported by e-learning modules and regular orientation. Guests, meanwhile, can be encouraged through green marketing, incentives, and small behavioural nudges.

As for policymakers, the priority is clear. Medium-sized hotels need tailored incentives, easier access to grants, and streamlined certification processes. Removing unnecessary financial and bureaucratic barriers will make it easier for smaller operators to commit to sustainability.

In the short term, hotels should focus on low-cost, high-impact actions that don't require major renovations—like digitalizing communication, introducing towel reuse programs, or installing water-saving devices. Continuous training also helps employees manage these practices without adding much cost. Over time, however, larger investments will be necessary. This includes solar systems, advanced water recovery, and retrofitting heritage buildings with greener technologies. Collaboration among hotels—for example, shared waste management or joint purchasing of eco-friendly supplies—offers another way to cut costs and strengthen collective impact.

In short-term for policy-level interventions, policymakers can play a crucial role by streamlining the process of green certification and reducing bureaucratic hurdles, which currently discourage medium-sized hotels from adopting sustainable practices. Financial incentives, such as small-scale grants or tax rebates, would enable hotels to adopt initial low-cost measures more confidently. In the longer horizon, structural support is required through dedicated sustainability funds for heritage hotels, subsidies for renewable energy adoption, and the introduction of heritage-sensitive regulatory frameworks. These measures can ensure that medium-sized hotels, particularly those operating in space-constrained heritage cities, are not disadvantaged compared to larger chains with greater resources.

Presenting the recommendations in a structured format allows the study to deliver practical guidance for the industry practitioners while also highlighting to policymakers the tailored forms of support needed to advance sustainability transitions within the medium-sized hotel sector.

5. Summary

This paper explored the challenges of introducing green practices in medium-sized hotels in Melaka, focusing on how hoteliers understand and approach sustainability. Using qualitative data from eight informants, the study provides richer insights into the real barriers and strategies faced in this often-overlooked segment of the hospitality industry. Unlike earlier research, which has mostly concentrated on large hotels or relied heavily on quantitative methods, this study makes a different contribution. It highlights the voices of medium-sized hoteliers and brings forward their lived experiences. The analysis revealed four main barriers to adopting green practices. These include difficulties in staff training and management, limited guest awareness and cooperation, high upfront costs for implementation, and space constraints which particularly in heritage buildings where structural changes are restricted. These obstacles highlight the difficulty of integrating sustainability into the everyday running of hotels where internal (staff, management) and external (guests, infrastructure, finances) components interact. In spite of these obstacles, the research also established a number of hotels that showed great interest in sustainability indicating that medium-sized hotels can play a vital role in advancing green in the Malaysian hospitality sector.

As with all research, several limitations must be acknowledged. This study focused only on medium-sized hotels in Melaka, which may limit the generalizability of findings to other states or larger hotels. Time constraints and scheduling challenges meant that some perspectives could not be captured. Furthermore, qualitative transcription and coding are resource-intensive, and the limited sample may not reflect the full diversity of experiences across the sector.

Future research should expand by adopting longitudinal designs to capture the long-term impact of sustainability practices on profitability, guest satisfaction, and operational resilience. Mixed-methods approaches would also strengthen findings by integrating quantitative measures of sustainability outcomes with qualitative insights from hotel managers. Comparative studies involving hotels across different states or within the ASEAN region could further contextualize the Malaysian experience and inform regional strategies for sustainable hospitality.

In conclusion, while medium-sized hotels in Melaka are increasingly embracing green practices, systemic barriers continue to slow their progress. Overcoming these challenges requires collaborative efforts from hotel managers, policymakers, and guests. By strengthening support mechanisms and adopting strategic approaches, medium-sized hotels have the potential to significantly contribute to sustainable tourism and to further Melaka's aspiration of positioning itself as a premier green city destination.

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INDOOR PHYSICAL AIR QUALITY PARAMETERS IN LECTURER OFFICES: A CASE STUDY AT THE CIVIL ENGINEERING DEPARTMENT, POLITEKNIK SULTAN ABDUL HALIM MU'ADZAM SHAH

Zamry Ahmad Mokhtar[1*], Nur Ashikin Lakman[2], Norliza Md. Yusof[3]

[1,2,3]Department of Civil Engineering, Politeknik Sultan Abdul Halim Mu'adzam Shah, Bandar Darulaman, 06000 Jitra, Kedah.

*Corresponding author's email: zamry@polimas.edu.my

Abstract

Indoor air quality plays an important role in supporting comfort, productivity and health for building occupants, particularly in educational environments. This study explores the indoor environmental conditions in lecturer offices at the Civil Engineering Department of Politeknik Sultan Abdul Halim Mu'adzam Shah. The main objective is to assess physical air quality parameters, including air temperature, relative humidity and air movement. Air temperature reflects how warm or cool the air is in a space and directly affects thermal comfort which can influence concentration and productivity. Relative humidity expresses the amount of moisture in the air. High humidity can make a room feel stuffy, while low humidity may cause dryness and discomfort. Air movement describes how air flows within a room. Proper airflow helps with ventilation, removes stale air and maintains a comfortable and fresh indoor environment. The data were collected using a psychrometer and an anemometer during an eight-hour workday, with hourly readings at three different locations in the offices. The collected data were then compared with standards set by DOSH, MS 1525 and ASHRAE. The results showed that air temperature generally complied with acceptable range, whereas relative humidity and air movement exceeded recommended levels. These results point to possible issues related to ventilation and moisture regulation that could contribute to thermal discomfort over time. The importance of routine indoor air quality monitoring and effective ventilation strategies is emphasized to ensure a healthy and comfortable working environment for academic staff.

Keywords: *Air movement; air temperature; indoor environment; relative humidity; workplace comfort*

1. Introduction

Indoor environmental quality (IEQ) in offices has long been recognised as a key determinant of workers' comfort, health and productivity. Large international surveys repeatedly show that thermal factors such as air temperature, relative humidity and air movement remain the attributes occupants notice first and report most often when they evaluate their workspace (Woo et al., 2021). Although many universities have renovated or purpose-built offices to improve comfort, recent empirical work still finds measurable dissatisfaction and performance losses that trace back to basic physical air-quality parameters (Che et al., 2019; Juhásová Šenitková, 2020). These findings are similar to the OFFICAIR study, which was conducted in eight European countries. The study found that even in modern office buildings with mechanical ventilation systems, temperature and humidity levels varied a lot. This caused different reactions from the people working there and could even lead to health problems (Mandin et al., 2016). This shows that having good equipment alone is not enough to ensure comfortable and healthy conditions where people actually sit and work.

In higher education institutions, lecturer offices form a unique indoor environment. Unlike open-plan offices used for administration, these rooms are usually small, packed with furniture and used in short but intense periods as lecturers move between teaching, research and student consultations. Studies from Australia and Europe have shown that while the overall indoor environmental quality (IEQ) in such offices may seem acceptable, there are often specific areas

with uncomfortable conditions such as hot spots, drafts or dry air that affect personal comfort (Woo et al., 2021; Mandin et al., 2016). However, most existing research focuses on general IEQ indicators or chemical pollutants. There is still a lack of studies that measure basic physical conditions like air temperature, humidity and air movement, especially in lecturer offices located in tropical regions.

In Malaysia's hot and humid climate, most studies have focused on classroom environments or energy-saving upgrades in commercial buildings (Che et al., 2019). However, very little is known about the everyday indoor conditions in lecturer offices, even though these are the spaces where important tasks like lesson planning, grading and student consultations take place. It is important to understand the micro-climate in these rooms to protect lecturers' well-being and support their teaching and research performance. In addition, studies related to COVID-19 have shown that temperature, humidity, and ventilation all play a role in the spread of airborne infections. This makes it even more important to collect accurate data in offices where one-on-one meetings happen regularly (Wolkoff et al., 2021).

Based on this context, this study examines the indoor physical air quality in lecturer offices at the Civil Engineering Department of Politeknik Sultan Abdul Halim Mu'adzam Shah. It focuses on three key parameters; air temperature, relative humidity and air movement. By collecting detailed data from each room and comparing it with established comfort standards, the study aims to fill a gap in research related to polytechnic environments in tropical regions. The results can help guide building management decisions and support the ongoing conversation about creating healthy and productive workplaces for academic staff.

2. Literature Review

Recent studies show that air temperature, relative humidity and air movement are the three main physical factors used to assess indoor air quality in offices. However, there is still debate over what the ideal values for these parameters should be. For example, a comparison of international standards such as ISO-17772 and EN-16798 found that they recommend a narrow "comfort" range, around 22 °C and 40–60% relative humidity which is based on offices in temperate climates and doesn't consider differences in local weather or room layout (Khovalyg et al., 2020). Fieldwork in Finland showed that even small changes away from 22 °C led to a noticeable drop in occupant satisfaction, while humidity only had a strong effect when it was too high or too low (Palonen et al., 1993). Similarly, a year-long study in Beijing found that although fresh air systems kept temperatures between 23 °C and 28 °C, people still reported feeling uncomfortable, showing that a single temperature target is not enough (Niu et al., 2022). These findings suggest that current standards are designed for general use but do not reflect the unique needs of small, private rooms such as lecturer offices in warm and humid regions.

Other research connects these physical factors to health and productivity. A large review from Europe found that common indoor complaints such as dry eyes, tiredness and lower work performance often result from a combination of poor air circulation and thermal discomfort. This shows the importance of studying both environmental and health aspects together (Carrer & Wolkoff, 2018). In Malaysia and Turkey, offices with high particle levels or carbon monoxide (CO) showed links to symptoms like sore throat, fatigue and increased absenteeism (Parmaksız et al., 2021; Rahman et al., 2014). In Iran, similar symptoms occurred even when pollutant levels were within safe limits, suggesting that physical factors like drafts and sudden humidity changes may be more influential than previously thought (Atarodi et al., 2018). A global review also stressed that indoor air can be four times more polluted than outdoor air, yet many studies still ignore simple comfort-related measurements (Mannan & Al-Ghamdi, 2021). Supporting this, Morawska et al. (2017) demonstrated that indoor particulate matter (PM10, PM2.5, ultrafine particles) in offices often originates from outdoor sources and may exceed

WHO limits, suggesting a need for better filtration and air exchange control strategies. Together, these studies reveal a gap, very few have investigated the relationship between temperature, humidity, air speed and health outcomes specifically in academic staff offices, especially in Malaysia's tropical climate.

Studies that aim to solve these problems are still limited. A pilot study in Sarajevo showed that applying special photocatalytic coatings on building surfaces could reduce outdoor nitrogen oxide (NO_x) levels by half, but it didn't explore how this might affect indoor comfort (Halilović & Alibegović, 2017). In Malaysia, low-cost Internet of Things (IoT) sensors can now track CO levels, temperature and humidity in real time. However, the data is rarely used to improve ventilation or staff comfort in office settings (Md Kamal et al., 2021). Other researchers emphasize the complex perception of air quality, where thermal, acoustic and air factors interact. For instance, Juodis et al. (2021) found that even when air quality was objectively acceptable, perceived discomfort often stemmed from a combination of thermal and acoustic disturbances. Additionally, studies such as Bashir et al. (2023) stress the cumulative burden of poor indoor air on vulnerable populations, showing that policy and technical solutions must also consider socio-environmental inequality. These technological and perception-based insights are advancing quickly, but the understanding of how they apply in real office conditions is still lacking. In summary, while the literature provides valuable insights into overall trends, pollutant health links and new technologies, there is still a major gap, as no study has yet fully explored how temperature, humidity and air movement interact in Malaysian polytechnic lecturer offices or how these factors affect staff well-being and teaching performance.

3. Research Methodology

This study used a descriptive case-study design to assess the physical air quality in lecturer offices at the Civil Engineering Department, Politeknik Sultan Abdul Halim Mu'adzam Shah. Since the objective was to understand real-time environmental conditions within a single location, not to generalize findings across multiple buildings, the case-study approach was considered the most appropriate. The lecturer-office block occupies less than 3,000 m² in total. The main working area where staff carry out tasks such as lesson preparation and student consultations measure approximately 59.5 m in width and 8 m in depth, giving a total floor space of around 476 m².

A purposive sampling strategy was used to select three measurement points in the office. These were located at the entrance, the central aisle and the far end of the office space. These points were chosen to reflect variations in environmental exposure such as proximity to doors, windows and air-conditioning vents. At each location, data were collected once per hour throughout a standard eight-hour workday (from 09:00 to 17:00), producing eight readings for each parameter at each location. Measurements were scheduled during a typical teaching week to ensure that occupancy patterns reflected normal use.

Two portable instruments were used. A sling psychrometer was used to obtain dry-bulb and wet-bulb temperatures, which were then converted into air temperature and relative humidity. An anemometer was used to measure air velocity (in m/s). Both tools were calibrated before use, following the manufacturers' guidelines. During measurement, instruments were held at approximately 1.2 m above the floor roughly the height of a seated person's breathing zone. After each hourly measurement, the values were recorded on a field sheet and later entered into a spreadsheet. For each location, average values were calculated for air temperature, relative humidity and air velocity. These averages were then compared to comfort

and health standards set by the Department of Occupational Safety and Health (DOSH), Malaysian Standard MS 1525, and ASHRAE Standard 55.

4. Result and Discussion

The mean air temperature recorded in the lecturer offices was 25.4 °C (see Table 1). This value falls well within the acceptable range set by DOSH and ASHRAE (23 °C – 26 °C), and it also meets the requirement in MS 1525 (24 °C – 26 °C). Past studies in Malaysian offices have found that split-unit or central air-conditioning systems are generally able to maintain temperatures within this range throughout the workday (Che et al., 2019; Woo et al., 2021). Similarly, international studies have shown that temperatures near 25 °C tend to produce the fewest complaints as long as humidity and air movement are also controlled (Mandin et al., 2016). Overall, this suggests that temperature control in the Civil Engineering Department offices is satisfactory.

The mean relative humidity was 71.31% (see Table 1), which exceeds all the recommended limits: DOSH (40%–70%), MS 1525 (50%–70%) and ASHRAE (30%–60%). High humidity is common in hot and humid regions like Malaysia, and it can make rooms feel uncomfortable, encourage mould growth and reduce indoor air freshness (Carrer & Wolkoff, 2018). Similar humidity levels in other Malaysian buildings have been linked to symptoms such as dry eyes and lower concentration, even when temperatures were acceptable (Che et al., 2019). In fact, studies from China and Europe report that productivity can drop by 4%–6% when relative humidity goes above 70% (Niu et al., 2022; Mandin et al., 2016). These results suggest that better ventilation or dehumidification systems may be needed in the lecturer offices.

The mean air movement was measured at 0.54 m/s (see Table 1). This is slightly above the recommended limit of 0.50 m/s set by DOSH and MS 1525, but still falls within ASHRAE's broader range, which allows speeds above 0.152 m/s. While light airflow can help improve comfort in warm environments, air speeds above about 0.5 m/s can start to feel unpleasant—especially for seated occupants (Khovalyg et al., 2020). Scandinavian studies show a clear rise in discomfort when air movement exceeds 0.6 m/s, even if the room temperature is comfortable (Palonen et al., 1993). This suggests that the slightly high air speed in the lecturer offices might reduce the benefits of good temperature control. Together with the high humidity, it indicates that the HVAC system cools effectively, but may not remove moisture or control airflow direction well enough. To improve comfort, solutions such as lower fan speeds, variable-air-volume diffusers or desiccant dehumidifiers could help bring humidity and air movement back within comfort standards, making the office environment healthier and more productive.

Table 1. Comparison of Measured Indoor Physical Air-Quality Parameters with Reference Standards

Parameters (Unit)	Measured Mean	Reference Ranges		
		DOSH	MS 1525 (2017)	ASHRAE
Air Temperature [°C]	25.4	23 – 26	24 – 26	23 – 26
Relative Humidity [%]	71.31	40 – 70	50 – 70	30 – 60
Air Movement [m/s]	0.54	0.15 - 0.50	0.15 - 0.50	>0.152

Figure 1 presents a comparative bar chart of the measured indoor air quality parameters; air temperature, relative humidity and air movement, against the average values of reference ranges established by DOSH, MS 1525:2017 and ASHRAE. The chart clearly illustrates that while the air temperature complies with all recommended standards, both relative humidity and air movement slightly exceed the typical comfort thresholds, reinforcing the need for improved ventilation and humidity control measures within the lecturer offices.

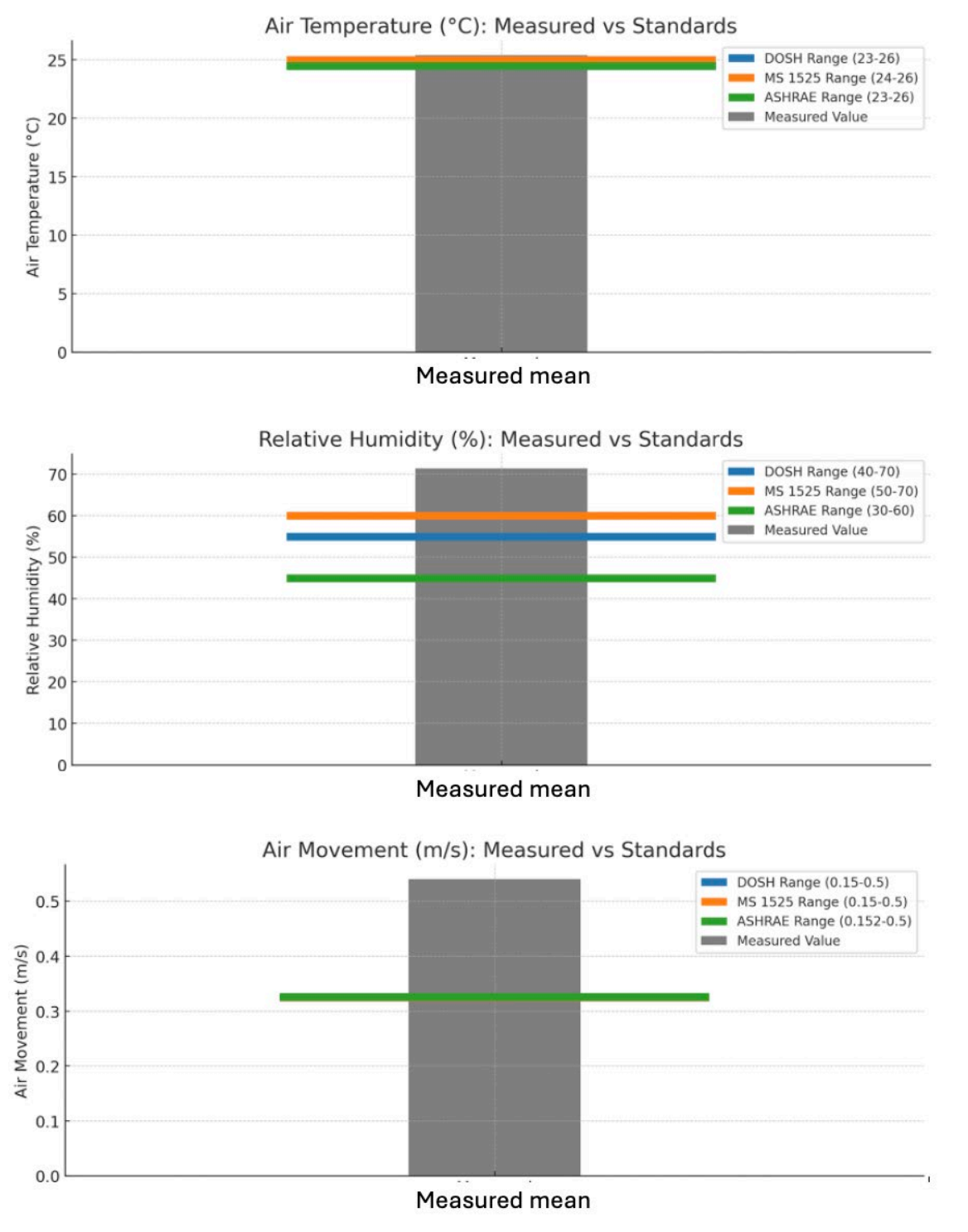


Figure 1. Bar chart comparing measured indoor air quality values with average standards from DOSH, MS 1525:2017 and ASHRAE

5. Conclusion

This case study investigated three key physical indoor air quality parameters, air temperature, relative humidity and air movement in lecturer offices at the Civil Engineering Department of Politeknik Sultan Abdul Halim Mu'adzam Shah. The mean air temperature was 25.4 °C, which falls comfortably within all recommended limits set by DOSH, MS 1525 and ASHRAE, indicating that the current cooling system is effective in maintaining thermal conditions. However, the mean relative humidity was 71.31%, which exceeds the 70% limit of DOSH and MS 1525, and goes well beyond the 60% guideline from ASHRAE. The average air movement recorded was 0.54 m/s, which is just above the 0.50 m/s limit in DOSH and MS 1525, but still within ASHRAE's broader acceptable range. These results show a mixed level of compliance, while temperature control is adequate, the removal of moisture and control of drafts appear to be less effective.

These issues related to humidity and air speed are not minor. Past studies have linked relative humidity above 70% to feelings of stuffiness, increased microbial growth and a decline in perceived air freshness, all of which can negatively affect comfort and work performance. Similarly, research shows that air speeds above 0.5 m/s, especially at seated-head height, can cause draft-related discomfort, even when the temperature feels normal. Taken together, the findings suggest that lecturers may feel thermally comfortable, but still experience hidden discomfort or health-related stress due to excess humidity and subtle air drafts. Improving these conditions is important for supporting staff well-being, maintaining productivity and fulfilling Malaysia's wider ambitions for healthy academic environments.

Further comparative studies across different departments or building types within polytechnics could help explain how design, occupancy patterns and ventilation systems interact with Malaysia's humid climate. Finally, testing targeted solutions such as demand-controlled dehumidifiers, adjustable air diffusers or personalised fans could offer practical, energy-efficient ways to bring humidity and air speed within recommended limits while preserving the already satisfactory temperature control observed in this study.

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Analysing the Experimental Performance of Hybrid Energy

Zarulrizam Bin Ab Jalil[1*], Norashikin Binti Amir[2], Faizatul Noor Binti Abu Bakar[3]

[1,2,3]Segamat 2 Community College , Segamat, Johor

*Zarulrizam019@gmail.com

Abstract

The Solar System, occasionally termed the "Solar Direct" system, is an alternative system capable of replacing the current energy sources that sustain human life. It generates power sources that supply electrical materials with energy; the system is a crucial element of this experiment. This hybrid power supply must be engineered with appropriate materials, configurations, and components that enhance energy storage for systems utilising green technology. Malaysia's proximity to the equator enhances the generation of electricity from sunlight, as this latitude experiences the most powerful solar radiation and the sun's closest approach to the Earth. Diversifying educational initiatives to enlighten the public about the importance of novel energy sources focusses on recently found energy types. The hybrid power supply is a method of energy collecting that considers both wind and solar sources as possible power providers. Experiments have been undertaken to construct a hybrid solar-wind power system that can generate energy and store electricity in batteries. In conclusion, hybrid energy systems that integrate solar and wind power can be employed in some places, as they generate electricity during both sunny and windy conditions. This hybrid power supply technology is utilised in the East Coast region of Malaysia, which has a prolonged monsoon season compared to other areas of the nation. It integrates the functionalities of two distinct power supply systems.

Keywords: *solar; wind; hybrid; power supply*

1. Introduction

Solar energy is the process of using sunlight to make energy that may be used. People have been using solar energy for thousands of years in many different ways. It has been used a lot when there are no other energy sources available, such in space and other places that are hard to reach. The industrial sector in our country grew from the 1980s to the 2000s. This caused power demand to double and greenhouse gas emissions to climb. Renewable energy is energy that can be used again and doesn't waste anything. Renewable energy, especially solares Cir casting, is a reliable and safe source of electricity that helps solve big desgues, such as climate change (Karaman/H. A on. al., 2021).

The fact that technology is always getting better and doesn't release carbon dioxide means we don't need oil as much and the air is cleaner. One approach to make sure that manufacturing stays strong in our country is to continually coming up with new ways to make energy that doesn't release carbon. When it comes to creating this technology, our country is still a long way behind rich ones. Colleges, universities, and corporations are still working together to make this technology better. This project needs to be better. Solar, wind, and water energy can all create a lot of power and be utilised to make electricity. This is an example of a renewable energy source that may be used for a long time.

Solar photovoltaic systems change sunlight into electricity, which means that people can create their own power. Solar cells make up the photovoltaic solar system. These cells are devices that turn light energy into electrical energy. People typically call them solar cells because the sun is the main source of light. "Photo" means light, and "voltage" means creating electricity. The phrase "photovoltaic" stems from these two words. The phrase "photovoltaic" is made up of these two words. So, photovoltaics is the process of "making electricity directly from sunlight." Photovoltaic is typically shortened as PV.

A wind turbine is a contraption that creates electricity by exploiting the wind. You can set it up such that it is either horizontal or vertical. Wind turbines with horizontal axes are more common. Wind turbines transfer the wind's kinetic energy into mechanical energy by using propellers or blades that are attached to a shaft. There is a generator on the shaft that turns mechanical energy into electrical energy. There are two main kinds of wind turbines: horizontal axis wind turbines (HAWT) and vertical axis wind turbines (VAWT). Wind turbines are becoming one of the most frequent sources of renewable energy since they create clean, green power without emitting greenhouse emissions. The system's performance and lifespan depend on the wind speed and consistency, the location of the installation, and the type of turbine technology used.

The main goal of this study is to find out if it is possible to make money by using solar panels and wind turbines together to make power. We will try out the strategy we came up with in a variety of circumstances and locations to see how well it works. The experiment took place around the end of the year in Mersing, which is in a part of the world that is impacted by the monsoon.

2. Literature

Solar-powered generators are autonomous systems that transform solar energy into electricity. They exhibit a superior success rate compared to solar systems integrated with the power grid. A grid-connected solar system operates on the principle of energy exchange through buying and selling. It additionally benefits the grid system, particularly during peak hours. Regarding energy conservation, this is not a significant endeavour. The grid system consistently generates excess electricity above requirements (Parida et al., 2011).

Renewable energy is the use of naturally existing resources that can be used to make power, like geothermal, wind, water, waves, and the sun. Solar, hydropower, biomass, and biofuel are all types of technology that can be utilised to create energy that doesn't run out. Researchers are researching at renewable energy sources as wind, tidal, biomass, hydropower, geothermal, and solar energy to make up for this deficiency. They are also aiming to avoid the issues that occur with using traditional energy sources (Yaw Long Chua & Yoon Kuang Yong, 2017).

In Malaysia, the energy that is utilised to provide electricity to clients is connected by a system of generation, distribution, and division. According to the Malaysian Energy Commission's Annual Report, Peninsular Malaysia has experienced an average annual increase of 3% in energy consumption since 2008. The rise in power demand is a clear indication of the rapid growth of Malaysia. Figure 1 illustrates the peak demand for energy supply in Malaysia between 1990 and 2018.

The utilisation of wind energy to generate beneficial forms of energy is known as wind power. Wind turbines generate electricity, windmills generate mechanical power, wind pumps facilitate the movement of water, and sailing propels a vessel. Wind energy is an exceptional substitute for fossil fuels due to its abundance, renewable nature, widespread application, environmental benefits, and absence of greenhouse gas emissions. Power to residences and businesses may be supplied by hundreds of wind turbines that are connected in a large wind farm. The development of wind farms is opposed by certain individuals who believe that they will obstruct the view. Wind energy is generally more environmentally friendly than other forms of electricity; however, this is not always the case. It is possible for wind power to meet up to 20% of the nation's electrical requirements; however, the wind does not consistently blow. However, if rates increase, it may be more difficult to maintain normal

production, network enhancements may be necessary, and expenditures may increase also. During periods of diminished wind power generation, it is possible to mitigate the issue by purchasing electricity from neighbouring states or reducing energy consumption. Although the technology is advancing at a rapid pace, wind turbines that are constructed correctly are still required in Malaysia due to the wind conditions. Gadgets that combine two or more renewable energy sources appear to be a viable option in this scenario. This hybrid method has been the subject of numerous studies, which have concluded that it is effective (Numan et al., 2020). Another renewable energy source that Malaysia may implement is wind power. Compared to other nations, Malaysia experiences relatively minimal wind velocities.

Winds in Malaysia are notoriously strong due to the Indian Ocean and the South China Sea. Each month, the wind speed ranges from 1.5 to 4.5 meters per second. The utilisation of wind energy is feasible in regions where the wind flows at velocities of 9 to 11 meters per second. The locations of Mersing, Johor, and Kuala Terengganu in Peninsular Malaysia are subject to significant gusts (M. R. Islam et al., 2012). On the other hand, the wind energy potential in East Malaysia is most significant in Kudat and Sabah.

3. Methodology

In this study, the hybrid system was examined, which utilised sunlight to power both the solar panel and the wind turbine. The information on the module that pertains to the Standard Test Condition (STC) indicates that the quantity of electrical energy that is emitted can be measured using a multimeter. The charge controller will transmit the DC voltage and current generated to the battery. Indicating that the battery is fully charged, the green light on a hybrid charge controller is illuminated, while the red light indicates that the battery is charging at a low voltage. Consequently, AC is capable of supplying the appropriate quantity of electricity to the electrical item or application. Testing is conducted during both day and night to guarantee that the approach can be implemented in the manner illustrated in Figure 1.



Figure 1: Testing is conducted during both day and night.

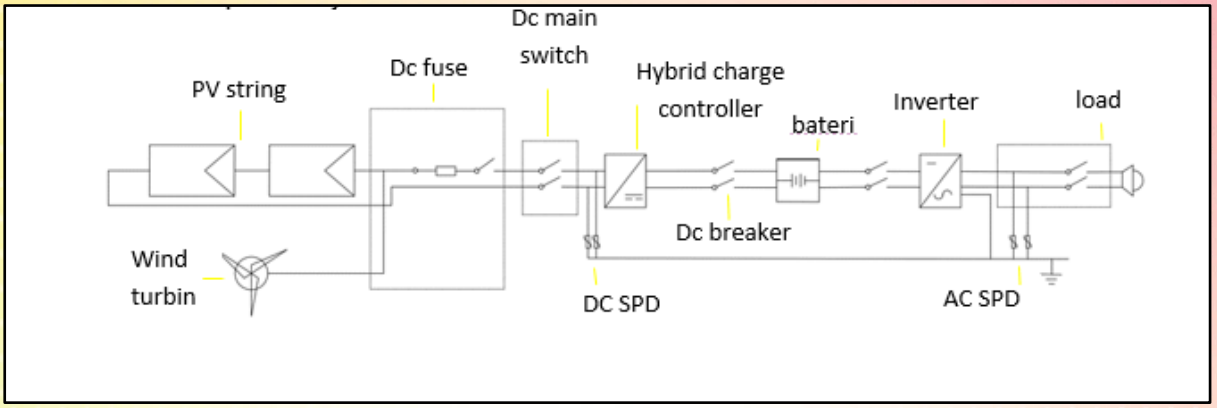


Figure 2 : Single Line Diagram of Hybrid Energy Syste



Figure 3 : Lead-acid battery



Figure 4 : Wind Solar Hybrid Charge Controller



Figure 5 : Components of a hybrid system



Figure 6 : Wind generator

4. Result

Testing is now underway to assess the feasibility of wind and solar energy generation. The solar energy test is conducted throughout the day, whereas the wind energy test occurs in the evening.

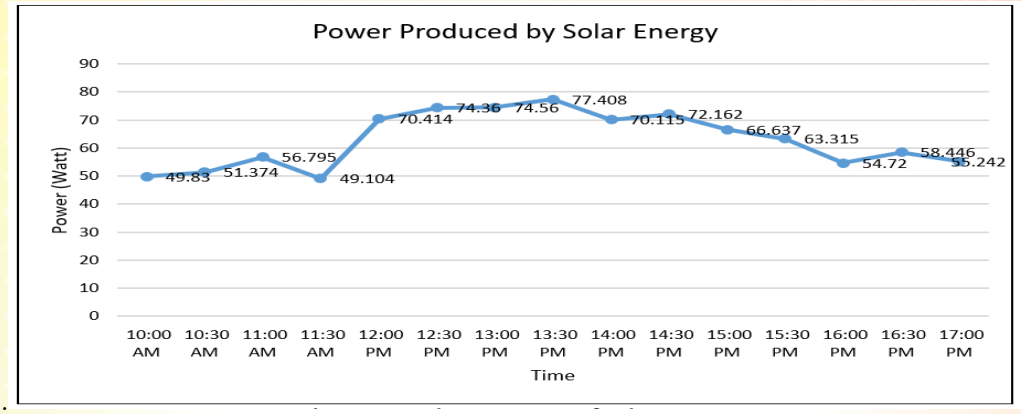


Figure 7 : The outcomes of solar energy

Figure 7 illustrates the energy generation during daylight, peaking during the Peak Sun Hour (PSH) and thereafter diminishing as darkness approaches.

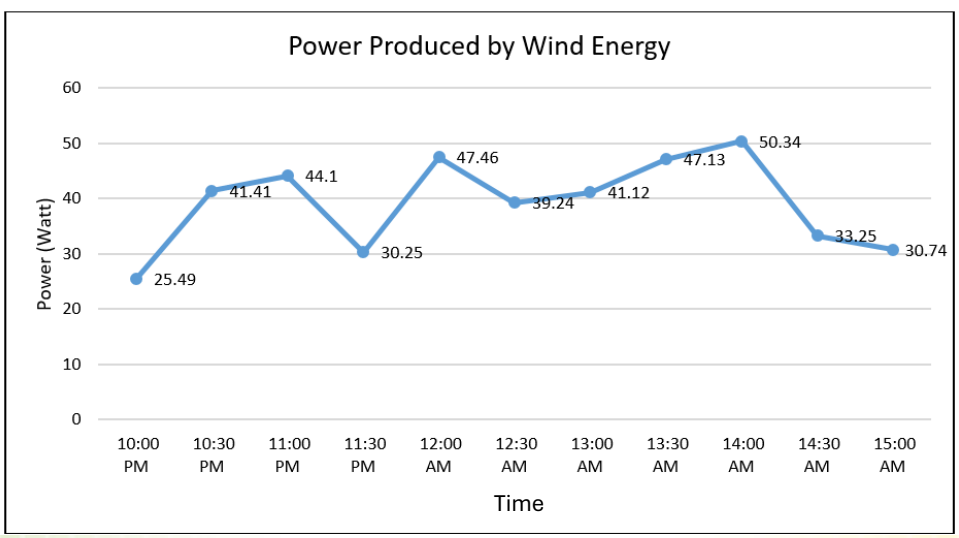


Figure 8 : The outcomes of using wind energy

There is a wind energy certification time that runs from 10:00 p.m. to 3:00 a.m. It is completed late in the evening, when the nocturnal breezes are at their most vigorous. Figure 8 illustrates the power generated by wind energy, indicating that electricity can be consistently produced late at night and early in the morning.

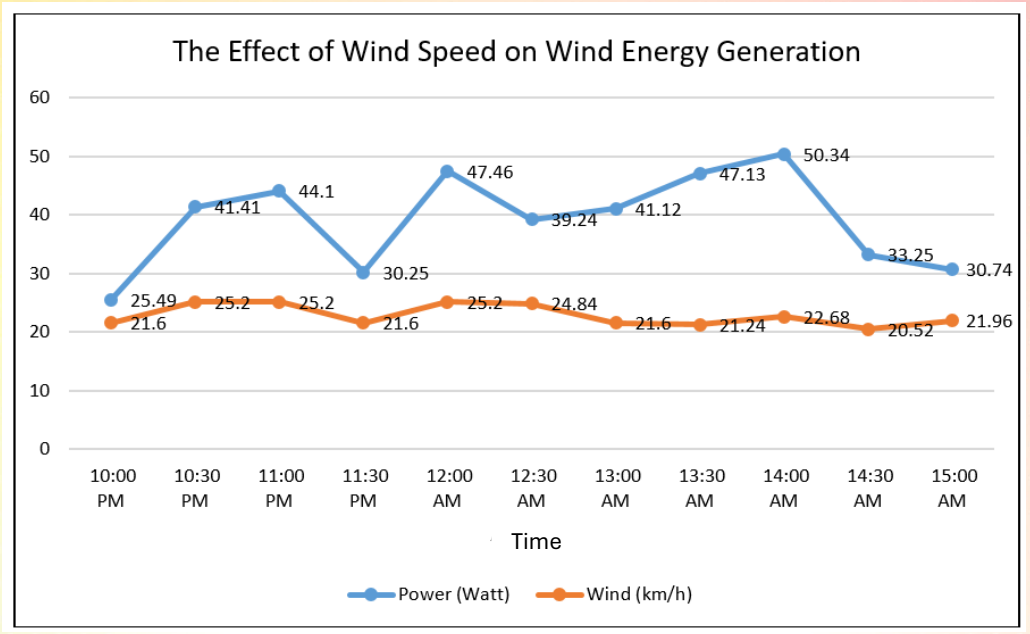


Figure 9 : The results of wind velocity

Figure 9 illustrates the correlation between wind speed and power generation. Electricity production increased by 62% between 10:00 and 10:30, accompanied by a 16% spike in wind speed. This indicates that variations in wind speed will influence the rate of power generation.

5. Conclusion

The hybrid wind-solar system creates power by putting photovoltaic cells and wind turbines together. It does this using fundamental parts including energy storage, power converters, and other control elements. The purpose of the construction is to make more room, lower costs, and lessen the harm to the environment that comes from making electricity in small towns and buildings that aren't connected to the power grid. These goals are all being worked on at the same time. In some circumstances, the technology behind hybrid systems can help with power supply concerns and make a community less dependent on the power grid. A solar-hybrid power supply could function in coastal areas where the wind is strong enough to turn wind turbines into electricity, as long as it can be altered enough to work there. Solar energy will also assist make electricity during the day. The invention gives people another option to get power besides solar and wind power. The suggestion for an improvement indicates that the project may be easier to move if the windmill poles had wheels and the framework was altered to support solar panels. Using Internet of Things apps with some system monitoring sensors can also help. Malaysia has a lot of wind power potential, which could help cut down on greenhouse gas emissions and give people more choices for energy sources. The government wants to make more renewable energy, and the use of wind energy in Malaysia is likely to expand because of ongoing research and development.

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Food, Culture and Identity: Generation Z's Skills and Knowledge in Preserving Malay Traditional Food

Nooriziana Md Ramli[1*], Aziimah Abd Aziz[2]

[1]Kolej Komuniti Kuala Pilah, 33-41, Jln Wira 2/6, Pusat Komersial Melang, 72000 Kuala Pilah, Negeri Sembilan.

[2]Kolej Komuniti Baling, Kota Baling Jaya Batu 42, Pekan Pulai 09100 Baling, Kedah.

*Corresponding author's email: jiynaramli@gmail.com

Abstract

Hari Raya festive food refers to the food prepared and served during cultural and religious festivals. It has become a long tradition for the Malay community to prepare and serve traditional Hari Raya meals during the celebration. This study aims to investigate the perception of convenience and ready-to-eat (RTE) Malay traditional food consumption and purchase intention among Generation Z, as well as the association with the factors that affect skills and knowledge of Malay traditional food consumption during Hari Raya. This study adopted an ethnographic approach that combined observation and interview methods to obtain objectives, focusing on a small group of Gen Z in Northern Malaysia. The finding indicates that Generation Z is more prone to consume and buy Malay traditional foods that are ready-to-eat and served during Hari Raya. This is to second that RTE and convenience traditional Malay food have an impact on and are linked to factors affecting their skills and knowledge. In addition, this study came to the same conclusion as the others, that our Generation Z is still lacking the skills and knowledge on preparing Malay traditional food that is usually served during Hari Raya. Despite the fact that they were aware of it, the data reveals the unexpected results that the majority of those in the sample displayed a willingness to learn more about the traditional foods of Malaysia.

Keywords: *Generation Z; Malay Traditional Food; Young Generation; Skills and Knowledge; Hari Raya*

1. Introduction

Malaysia is a multi-racial country, with a population that is diverse in terms of race, religion, and ethnicity. Malays, Chinese, and Indians make up the largest population group in Malaysia (Jaafar, 2021; Abdul Raji et al., 2022; Md Ramli et al., 2023). Due to multi races country, the cuisine and gastronomy of Malaysia are renowned for their diverse and complex flavour profiles. As a cosmopolitan society, Malaysia has inherited a wide variety of cuisines and has even evolved its own fusion blends that are distinctive and characteristic of Malaysian cuisine. Hari Raya festive food refers to the food prepared and served specifically during cultural and religious festivals. It has become a long tradition for the Malay community to prepare and serve traditional Hari Raya meals during the celebration. According to Azman et al. (2024), the main dishes served during this festival are beef and chicken served with ketupat, nasi himpit, and lemang.

Food preparation and servings among Malays as part of the Hari Raya celebration have evolved into a long-standing custom that is passed down through the generations (Suleiman et al., 2023). The young generation, which is Gen Z, plays an important part in maintaining the local traditional foods. In Malaysia, Generation Y (27%) and Generation Z (26%) constitute the largest generational groups, significantly outnumbering the Silent Generation (4%), Baby Boomers (6%), and Generation X (21%) (Sautova et al., 2025). The data suggest that Generation Z comprises a significant demographic group and is increasingly asserting its societal presence. According to Azman et al. (2024), young generations can and may serve as cultural mediators as well as marketing and branding agents for traditional foods, which is essential in ensuring the long-term sustainability of local traditional food production. However,

younger generations are also crucial in maintaining traditional foods in the face of fast modernization.

Consequently, the pervasive reach of globalization and the prioritization of modern, time-efficient lifestyles have led to a noticeable shift toward fast food and convenience food consumption (Basurra et al., 2021). Traditional culinary practices are being overshadowed, raising questions about their longevity and relevance in the face of changing societal norms. Due to technological advancements, such as convenience ingredients, traditional Malay foods have lost much of their original flavour and texture. Nevertheless, there were a few concerns and problems that arose in relation to the preservation of traditional Malay food. Since traditional food was tightly connected to the ingredients, preparation process, dishes, and dining etiquette, there are significant worries and attention dedicated to the preservation of traditional cuisine (Azmi et al., 2024; Azman et al., 2024). Therefore, this study aims to investigate the perception of convenience and ready-to-eat (RTE) Malay traditional food consumption and purchase intention among Generation Z, as well as the association with the factors that affect Generation Z's skills and knowledge of Malay traditional food consumption during Hari Raya. The traditional Malay food preparation and serving have evolved into a long-standing custom that is passed down through the generations (Azman et al., 2024; Mohd Fisol et al., 2024). The concern arises since the traditional cooking knowledge that should have been passed down from generation to generation has steadily diminished, several ethnic groups are said to be suffering from deskilling challenges connected to domestic cooking skills and traditional food culture (Suleiman et al., 2023).

It had been proved by a previous study from Azman et al. (2024) that Malay youth today lack of knowledge and skills in their traditional foods especially in ketupat weaving. Instead of learning how to create traditional foods from their moms or elders, they prefer to buy them. When new generations no longer practice the culinary traditions, they were taught, there is a rising realization that traditional food knowledge may be lost and difficult to reproduce (Azman et al., 2024). Kamaruzaman et. al (2022) agreed that nowadays people especially younger generation are used to fast solutions in daily life. Instead of learning to cook from elders, most prefer to just buy their meals even when it comes to traditional food.

It was necessary to take measures throughout this manner so that the authenticity of the food would not be lost but would be passed on to future generations. According to Mulok et. al (2025), the traditional dishes help people stay connected to their cultural roots. Previous study by Abdul Raji et al. (2022) and Aris et al. (2022) highlighted, that the transmission of traditional food knowledge is essential for ensuring the continuation of traditional food practices among the next generation. There is lack of recent studies has been conducted especially on Generation Z and Malay traditional food in Malaysia. As a result, the study investigates the perception of convenience and ready-to-eat (RTE) Malay traditional food consumption and purchase intention among Generation Z as well as the association with the factors that affect Generation Z's skills and knowledge of Malay traditional food consumption during Hari Raya.

2. Literature Review

2.1 Malay Food Culture

The culture and traditions of the Malay people provide tourists to Malaysia with a plethora of opportunities to learn and immerse themselves in the country's history (Asiaexchange, 2022). Jaafar (2021) seconded that it is largely due to the contributions of multiracial populations to Malaysia's rich culinary heritage that the country has been known as a cultural

melting pot. Despite the fact that Malay cuisine has its own particular flavour, it has been shaped by the culinary traditions including those of the Arabs, Indonesians, Thais, Bugis, Minangkabau, Chinese, and Indians (Abdul Raji et al., 2022). As a result of the wide variety of spices and herbs used, Malay cuisine including traditional dishes is often described as spicy and savory (Abdul Raji et al., 2022; Sa'min et al., 2024).

Due there is the abundance of locally accessible resources in this nation, it is feasible to produce meals that are authentic, flavorful, and savory. According to Abdul Raji et al. (2022), back in the day, the majority of the ingredients that were used in Malay cooking originated from the home's garden or natural sources. This contributed to the distinctive flavour of the food as well as to its allure as a culinary experience. Hence, the characteristic of Malay cuisine, according to Abdullah et al. (2021), is the abundance of herbs and spices, as well as the prominent role played by coconut milk and a high level of heat (Abdul Raji et al., 2022). Regardless of the cuisine, Malay celebrations such as Hari Raya Aidilfitri and Hari Raya Aidil Adha are the most celebrated festivals, where most families would host get-togethers during the celebration and offer excellent traditional Malay cuisines and desserts to guests.

2.2 Malay Traditional Food During Hari Raya

Food traditions play an important role in local culture by helping people connect, build a shared identity, and strengthen community ties (D'Andrea & D'Ulizia, 2024). The intake of food, which is a reflection of a people's ancestry, may be used to recognize traditional cultural practices that are practiced by Malay populations. According to Tangankraf (2023) indicate, that eid food, generally referred to as Aidil Fitri or Aidil Adha food, is food that is cooked and served specifically for the Malay cultural and Muslim religious celebrations internationally. According to Yem (2025), Hari Raya celebrations in Malaysia include a wide range of delicacies, from the traditional rendang to the must-have lemang. Abdullah et al. (2021) stated that lemang, rendang, ketupat, and a few more words conjure up images of a Malay Eid cultural celebration.

Ketupat is typically prepared in huge quantities and consumed during celebrations and holidays such as Eid ul-Fitr, which is a holiday celebrated by Muslims to mark the conclusion of the month-long fasting month of Ramadan (Willers, 2024; Yem, 2025). In addition, during these festivals, lemang, which is made of glutinous rice, is created and then cooked in bamboo tubes, and ketupat, which is made of rice or glutinous rice wrapped in leaves, is prepared. The lemang is served with a meal called rendang, which is cooked with beef or chicken, chili, and several spices (Setiarto & Tresnadiana Helina, 2024). Because each state and hamlet in Malaysia has its own take on rendang, it is hard to stake a claim to any exclusive rights to the dish. Rendang is made by stewing a variety of meats, as well as fish and vegetable shoots. During Hari Raya, a sauce created from roasted or fried peanuts might be all that is needed to complete the rice-eating experience. Molok & Liew (2021) have listed out that this spicy peanut sauce is one of the traditional foods that is commonly served during Hari Raya, and it is best to served together with chicken or rendang satay.

2.3 Convenience and Ready-to-eat (RTE) Malay Traditional Food Perceptions

Convenience foods, including traditional Malay cuisine, are becoming increasingly popular in today's society, indicating that Malay consumers have come to appreciate the benefits that traditional foods offer (Sharif et al., 2021). Food that is considered to be convenient is food that saves both time and effort, in addition to simplifying the process of

passing on one's culinary abilities to another. Rahman et al. (2021) came to the conclusion that convenience is about reducing the amount of time and effort used, and they all concur with this assertion. According to the findings of Sharif et al. (2021) research, efforts comprise both mental and physical exertion, and they encompass a variety of tasks that contribute to the generation of mental and physical energy as part of the food preparation process. Despite the fact that convenience ingredients are a product of the evolution of the food industry, which has resulted in traditional Malay foods losing their distinctive qualities. In addition, controversies have arisen surrounding the modernization and fusion of Malaysian traditional foods, with both researchers and consumers expressing concern over the potential dilution of cultural identity and the loss of authenticity in local food heritage (Azmi et al., 2023). Sharif et al. (2021) highlighted that processed, pre-prepared, and convenience food and ingredients have become more common in retail and foodservice venues, making the younger generation less inclined to embrace traditional food preparation habits. Nevertheless, a few studies contradict and stated that the availability of ready-to-eat foods however could be able to encourage younger generations to continue preparing traditional Malay dishes (Rahman et al., 2021; Sharif et al., 2021).

Convenience foods help reduce the amount of time spent cooking and preparing food, which makes it easier for younger generations to carry on traditional Malay cooking techniques. According to Sharif et al. (2021), the entrance of convenience foods and modern equipment into the market has resulted in a little modification of traditional aspects, notably food, cooking equipment, and eating utensils. Furthermore, RTE meals are consuming by younger generations for many reasons, including a lack of cooking skills or limited free time (Sharif et al., 2021; Azman et al., 2024). All of these constraints had caused more traditional food items, such as frozen ketupat, quick *nasi himpit, serunding, rendang,* and so on, to hit the market as a result of the increased desire for traditional food among Generation Z.

The younger generations are comprised of educated and employed individuals and are unable to prepare and cook meals because they are too exhausted, and they do not have enough time, therefore they choose ready-to-eat foods (Basurra et al., 2021). According to Choi (2022), the combination of a hectic lifestyle and access to an expansive and complex food universe via the internet has resulted in a distinct style of eating and food selection among members of Generation Z. The positive perception of convenience and ready-to-eat foods among Malaysian consumers especially younger generations is reinforced by their substantial exposure to and understanding of these products in the commercial food sector (Sharif et al., 2021). It is possible that ready-to-cook items may pique the interest of customers who favour using fresh ingredients and starting from scratch in the kitchen. According to Polat & Onbasi (2024), the culture of Malaysia is experiencing a profound process of modernization. Though globalization affects cultures broadly, Malay culture stands as a clear example of one that has been significantly shaped by its influence (Aditia, 2024). The fact that convenience ingredients are a product of the food industry's evolution has resulted in traditional Malay foods losing their distinctive qualities. Azman et al. (2024) pointed out that traditional food was strongly linked to the ingredients, preparation method, dishes, and eating etiquette, there are considerable concerns and effort committed to the preservation of traditional cuisine.

2.4 New Era: Generation Z Foodways Practices on Malay Traditional Food

According to Wikipedia (2025), the term "Generation Z," also known as "iGen" or "zoomers," refers to those individuals who were born between the years 1997 to 2012. Gen Z, often known as iGen or post-millennials, is a very collaborative group that cares profoundly

about people and is realistic about inheriting challenges (De Witte, 2022). To relate this generation and food, both in terms of how it is prepared and how it is consumed (sometimes referred to as "foodways"), has played a significant part throughout history in the planning of celebrations (Ossowska et al., 2024). According to Rocillo-Aquino et al. (2021), food resembles traditions among all generations.

However, a few studies found that this young generations, are less engaged, less capable, and generally unconcerned with tradition, particularly when it comes to heritage or festival food practices (Misran et al., 2022; Azman et al., 2024; Kamaruzaman et al., 2025; Mulok et al., 2025). Hashim et al. (2024) stated that due to the modern era, young generations nowadays have insufficient knowledge of how to prepare traditional dishes, particularly Malay food, compared to the generations before them who had a basic concept of how to prepare traditional foods and the continuity they received from their late grandparents or moms. In addition, according to Misran et al. (2022), the younger generations of each ethnic group are predicted to be less competent in cooking their traditional festival food.

Hashim et al. (2024) indicates, that the commercialization of ingredients and the rise of convenience meals, as well as technological improvement in cooking equipment and utensils, as well as social advancement through economic circumstances, educational level, and lifestyle directly contribute to the process of change. Regrettably, the changes will result in a marked decline in the use of traditional food production and consumption among community members, particularly among the younger generations of the population (Azman et al., 2024). Globalization, technical improvements in the food sector, and time restrictions are causing the younger generation to choose ready-to-eat dishes over traditional cuisine (Misran et al., 2022). According to Sharif et al. (2021) the study highlighted that the younger generation is less likely to adopt traditional food practices because of the increased penetration of processed, pre-prepared, and convenience meals in retail and food service establishments. As a result of advancements in technology, the preparation of dishes for celebrations is becoming significantly more effective in terms of both its use of time and its use of resources (Sharif et al., 2021).

In addition, young generations are said to be discouraged from engaging in Malay traditional festive foods due to a lack of knowledge and skills in Malay traditional cuisine, as well as a lack of support and exposure from their families (Azman et al., 2024). Besides that, there is also a lack of interest in traditional food preparation among younger generations, which may be one of the reasons why they are more likely to consumed modern foods (Hashim et al., 2024). According to Abdul Raji et al. (2022) and Azman et al. (2024), traditional Malay food demands a lot of effort and time. Traditional Malay cooking methods and techniques use a few basic kitchen utensils to prepare authentic Malay dishes from the scratch. Willers (2024) stated that traditional Malay food is time consumed. In ketupat making, casings, or pouches, constructed of coconut leaves are used in the cooking process of ketupat. Before the rice is cooked, a pouch made of coconut leaves that has been weaved in a crisscross pattern is used. The pouch is then filled with rice before proceeding to the boiling process, making the process complicated. The cooking procedure takes a very long time, and the younger generation has less patience while waiting for it to finish (Azman et al., 2024). This has been seconded by Md Ramli et. al (2023) this young generation are most likely lack of interest and had a stigma of making authentic food will actually prolonged time.

A study finding by Suleiman et al. (2023 and Azman et al. (2024) had stated that it is essential for traditional food knowledge to be passed down from one generation to the next in order to ensure that younger generations will continue to engage in traditional food practices.

According to Abdul Raji et al. (2022), the study mentioned that the preservation of diverse heritage foods to the present day underscores the historical continuity of culinary practices passed down through successive and young generations. Hence, in the context of the Malay community, women play a pivotal role as agents of intergenerational knowledge transfer, particularly in the preservation and dissemination of traditional culinary practices across generations (Mohd Fisol et. al, 2024). In addition, Chukwurah et al. (2025) stated that the high level of cultural significance fosters a feeling of 'belonging' and contributes to an increase in people's pride, both of which contribute to an increased likelihood that individuals would be eager to protect and maintain their cultural culinary tradition. As a consequence of this, enhancing the skills and knowledge of younger generations helps to conserve traditional Malay dishes, which are currently among the most valuable forms of knowledge (Kamaruzaman et al., 2022; Suleiman et al., 2023; Azman et al., 2024). Furthermore, the process by which a culinary tradition or skill in the kitchen is passed down through generations of a family or among friends and acquaintances is referred to as the transmission of food knowledge (Radzuan et al., 2024; Al-Sayed & Bieling, 2025). An informal education frequently includes the practice of passing down the recipes and methods of food preparation from one generation to the next, that has been in the family for generations and was commonly incorporated.

3. Methodology

3.1 Qualitative Study Approach

This study is exploratory research, and its purpose is to gain a better understanding of the factors that influence people's perspectives and motivations. Qualitative methods were deemed appropriate for this study, as they enable researchers to investigate the rich, contextualized meanings that people derive from their personal and social experiences (Azmi et al., 2023). Moreover, the population in this study involves Generation Z from Malay families that are residential in Northern Malaysia. The sample for this study was five individuals from Generation Z who are born from 1997 until 2012. According to Ahmed (2025), the optimal sample size for traditional qualitative studies to reach data saturation or redundancy typically ranges from 5 to 30 participants. A convenience sampling technique is conducted to collect data from a population that is convenient in terms of proximity and accessibility. In order to acquire the necessary information from the selected sample, 15 minutes face-to-face interviews were conducted with a series of six open-ended interview questions to lead the samples through the process of sharing their knowledge, experience, and opinions about ready-to-eat (RTE) food and Malay traditional food during the festival of Hari Raya. Furthermore, the study also employs the observation method to tap into food preparation skills and knowledge and convenience food involvement. Pictures are used as evidence in the study as data to observe the young generation's behavior on skills and knowledge that inspires them to involves in preparing Malay traditional foods for Hari Raya.

The data were manually analyzed by stages through Thematic Analysis and by using Microsoft Word, Microsoft Excel and Text Analyzer. The procedure for analyzing the data from the study is carried out in accordance to Taylor (2022). Furthermore, according to Naeem et. al (2023), as a widely recognized qualitative technique, thematic analysis facilitates the organization and examination of complex, detailed data by highlighting recurring themes and underlying meanings. These themes assist the study in making sense of the information and gaining meaning from it as a result. In this study, the results will be drawn after the raw data have been coded, organized, and categorized. The written data from the interview fieldnotes were divided based on the sequence in which the questions were asked during the interview.

The data that was gleaned from the application of keyword coding were compiled and computed in a spreadsheet created in Microsoft Excel. The coding implied In vivo coding type where the code is taken directly from the sample responses or quotes and also uses descriptive coding where a single word or noun encompasses the overall concept of the data to provide a concise summary of the extracts. Descriptive names for the themes were developed in order to facilitate engagement with the codes category or sub-themes discovered.

As a result of the prior process emphasis on research objective (RO1) with the theme, two (2) themes consisting of purchase intention and RTE consumption are relatable in answering the research question on the perception of convenience and RTE Malay traditional food in terms of consumption and purchase intention among Generation Z during Hari Raya. Meanwhile, to engage research objective (RO2), ten (10) different code categories were identified, and these ten (10) codes were further divided into four (4) distinct themes: food modernization, cooking interest, time consumption, and cooking technique. These themes are relevant and associated with the study's research question on the factors that affect skills and knowledge of Malay traditional food preparation among Generation Z during Hari Raya.

4. Findings

4.1 Convenience Food or RTE Food Consumption

Based on the findings, convenience and RTE Malay traditional food lay a good and acceptable insight among Generation Z. Generation Z believes that the convenience and RTE food provide more advantages and benefits to them as be served during Hari Raya. The perception toward it is that the convenience and RTE Malays traditional foods are convenient and could ease or save their time rather than spending their time very long preparing and cooking the food. In addition, convenience and RTE Malays traditional foods are also easy to prepare where it acquires only minimal preparation.

In regard to their food consumption, it has resulted that Gen Z and their family often purchase the convenience and RTE Malay traditional as to be served during Hari Raya. In addition, Generation Z buying preference is stimulus by family behaviour. Gen Z and family prefer RTE food eating rather than traditional or manual preparation and cooking. Therefore, it resulted that Generation Z had the same perception regarding RTE food as they preferred to consume and will never hesitate to purchase convenience and RTE Malay traditional foods as to be served during Hari Raya. On the other hand, the data do not reveal a good outcome owing to their skills and knowledge of traditional Malay cuisine.

With the observation and interviews gathered, the researcher can see that convenience food and RTE food will help the younger generation to prepare their traditional Malay dishes properly as it provides the guidelines of cooking methods on the packaging, and all the ingredients are provided. RTE consumption is a choice because it saves time, makes quick preparation delicious and convenient, and is also easy to prepare. Most of the samples, which are four (4), agree with the consumption of convenience food and RTE food. However, one (1) of the samples disagrees with RTE or convenience food consumption because he prefers to cook from scratch in order to gain more feelings and satisfaction from cooking traditional Malay foods for Hari Raya with his family.



Figure 1: Ketupat Cooking Preparation and Process for Hari Raya

4.2 Purchase Intention of convenience food or RTE

According to the observations, the word "purchase intention" appears three times in the theme occurrence. Some families have not followed or continued the family culinary tradition for the Hari Raya festive celebration, which has indirectly encouraged the younger generation not to practice traditional foods. According to Md Ramli et. al (2023), the younger demographic exhibits a significant gap in traditional food literacy, necessitating targeted efforts to enhance their understanding and competencies. This gap stems from a combination of disinterest, challenges in recognizing essential ingredients, lack of exposure to traditional food preparation methods, the prolonged time required for authentic cooking, ineffective transmission of culinary knowledge across generations, and the ease of purchasing ready-made traditional dishes from stores or online vendors. Referring to the Malay tradition of Hari Raya, which requires serving the food to families and relatives, these families prefer to buy convenience food due to a few considerations such as time constraints, lack of cooking interest, lack of cooking technique, or complicated preparation process. Their daughters or sons will use convenience or RTE products to shortcut the cooking process. One of the transcriptions of the responses is as follows:

> *"Definitely I will say yes. I will buy RTE foods. It makes me easy to prepare food. My family also purchase this RTE food to use when Hari Raya. It helps ease the difficulty of preparing the Hari Raya traditional food that we are unfamiliar with. Haaaa, and it's also delicious and convenience for me."*

4.3 Food Modernization

Based on the interviews and supported by observation, however, it leads to a disappointment in regard to skills and knowledge of Malay traditional food where most of the samples pointed out that advancement or modernization lessens the practices. In this perspective, they referred to advancement or modernization as a transformation process comprising education, entertainment, the environment, and lifestyles.

Some of the sample's state that their family always uses this instant food, so they do not know what the actual preparation process of that food is. The reason is that many traditional Malay dishes require attention and time to prepare and cook. Hence, the young generation attitude nowadays prefers to do tasks requiring less commitment and time-consuming.

Moreover, the study found had resulted that convenience and RTE food of Malay tradition also affect the modernization-related factors that influence small shifts in food preparation and consumption practices, as well as food's look and acceptability (Sharif et al., 2021).

4.4 Cooking Interest

Cooking interest also affects our Generation Z skills and knowledge based on observation and interviews. Learning chances, learning sources, skill, and cooking participation was observed under this factor. To relate with the knowledge, it is satisfactory that Generation Z recognizes Malay traditional foods usually served during Hari Raya. Ketupat, rendang, lemang, and kuah kacang are the signature dish that Generation Z had stated. Five of the samples agree with that. They even expressed how important it is to serve Malay traditional food during Hari Raya as it might be seen as unique as the festive Malay signature dish. However, knowing and recognizing the food does not measure Generation Z's skills and knowledge. As in the fieldnote transcripts, the sample stated:

> *"Malay traditional foods are significant in creating a festive mood. It is an ideal symbol of the lifestyle of Muslims in Malaysia. It creates the meal differences from our normal daily dishes. Like we knew Ketupat served during Hari Raya and not in our daily life."*

Four of five samples were interested in learning traditional Malay food. Samples that come from a family that still has an old generation and they had a passion for learning, will get the opportunity to learn by participating and also experiencing the cooking process. The older generation will pass down the skills and knowledge to the young generation. Meanwhile, samples from busy working families or who lack interest in cooking will prefer to use convenience food or RTE to serve meals during Hari Raya.

4.5 Time Consumption

Based on the interview and looking at the process of preparing traditional Malay, the process of preparing traditional Malay food is too complicated and hard to learn. The allocation time for preparation of Hari Raya food takes a long time depending on the food types. The tradition of Hari Raya, which needs to serve the guest our traditional foods on that day, indirectly increases the time of preparation due to the large quantity. Of three samples, only one sample of interviewees was not interested to learn cooking practices due to time consumption; she expressed:

"No, for me, I think I don't interest in learning cooking. It is too complicated and hard to learn the correct way to cook. Better for me to buy convenience food because I do not have much time to prepare the food. Owh, I also don't always have time to spend with my family because I have to study and do a lot of work."

Moreover, it has indirectly required time to find the various raw ingredients and prepare with the correct technique and method. Keeping the time and effort needed to prepare traditional Malay food has led this young generation to indirectly seek a simple approach to simplify and minimize the time required to prepare this traditional food.

4.6 Cooking Technique

An observation made during this study found that the younger generation lacked exposure and encouragement due to traditional Malay food's tedious and complicated cooking techniques. It involved many steps and procedures. For example, Figure 2 show the step-by-step in making a r*endang* which starts with getting fresh coconut milk by squeezing the grated coconut meat and straining the thick liquid from it. Subsequent by making the *kerisik* from freshly grated coconut, blending various raw materials until finished with garnished turmeric leaves or kaffir lime leaf. Getting various Malay raw ingredients, such as herbs and spices, is also tricky. Numerous ingredients such as tamarind paste, shrimp paste, candlenut, cardamon, cloves, star anise, fennel, cumin, and so on confuse these younger generations.

Moreover, factors such as studying away from parents make this younger generation lack of opportunity for them to learn the cooking technique and processes commonly. This situation will affect the family food traditions if the parents do not practice and pass down the knowledge and skills of the cooking technique.

Due to the complex cooking techniques and skills necessary for producing traditional Malay cuisine, young generations try to find alternate ways to simplify the cooking process. The cooking process will be more straightforward, especially when they have limited time to prepare the food.



Figure 2: Step-by-step process of making rendang, starting from extracting fresh coconut milk

4.7 Learning Willingness

Usually, food knowledge and skills of cooking traditional Malay food are transferred by communication, observation, and practice. From the observation, without any cooking activities by the senior generation, it may be difficult for the younger generation to learn and contribute to the traditional food practices, especially during Hari Raya. However, if the old generation actively cooks but the younger generation is not ready to learn and help, this will lead to a reduced number of the young generation that does not know how to prepare and cook the traditional food of Malay, especially during Hari Raya. The acquisition of culinary knowledge is influenced by the presence and receptiveness of potential learners. When an individual exhibits a strong inclination and commitment to learn, they are more likely to assimilate the expertise conveyed by the knowledge holder (Mulok et al., 2025). Thus, because young people are still learning, they impossible to keep up with the pace of doing the dishes without learning acceptance. Learning acceptance and willingness are the main keywords to transfer the skills and knowledge of traditional Malay foods during Hari Raya from the older generation to the young generation.

5. Discussion and Conclusion

By analyzing the results, Generation Z has a positive and favorable perception of the convenience of RTE Malay traditional foods due to the fact that it is convenient. As a result of this, it indicates that today's Generation Z is more prone to consume and buy Malay traditional foods that are ready-to-eat served during Hari Raya. Most of the samples in this study agreed that this is because it is more convenient to consume as opposed to the difficulty of preparing and cooking from scratch (Sharif et al., 2021; Azman et al., 2024). Furthermore, food modernization, cooking interest, time consumption, and cooking technique are the four factors that affect Generation Z's skills and knowledge of Malay traditional foods during Hari Raya.

This is to second that RTE and convenience traditional Malay food obviously influence and is associated with the occurrence of factors that have an effect on their skills and knowledge. It led to an agreement with Polat et al. (2024) that the modernization is exerting a substantial influence on Malaysian culture, leading to notable changes in traditional values, practices, and societal norms. There is a possibility that the food industry in Malaysia will gain from this, but not for young generations. However, Kamaruzaman et al. (2022) in their study on the practice of preserving authenticity in traditional Malay kuih among producers in Klang Valley that given the close association of traditional food with its ingredients, preparation methods, dishes, and dining customs indicate that there is much concern and focus on the preservation of traditional cuisine. This study has proved by Sharif et al. (2021) and Rahman et al. (2021) that the young generation is less likely to adopt traditional food practices because of the increased penetration of processed, pre-prepared, and convenience meals in retail and foodservice establishments. It contradicts the findings from Rahman et al. (2021) whom the data illustrates that, although modern influences such as convenience foods and technological innovations are reshaping domestic practices, women in Malay society continue to uphold cultural traditions rooted in long-standing communal values and knowledge systems

The purchase intention of Generation Z will continuously contribute to the growth of convenience and RTE Malay traditional food in the industry. Azman et al. (2024) further assert that younger generations have grown apathetic towards the customs of Malay traditional cuisine, which are gradually being supplanted by manufactured convenience foods (Sharif et al., 2021). The use of convenience food is not necessarily negative, since we are well aware that this type of food has become an indispensable part of our everyday lives. However, as long

as Generation Z has sufficient skills and knowledge, the original quality and texture of the traditional food items are maintained, the use of convenience foods will not necessarily deface ethnic traditional food (Sharif et al., 2021).

Ketupat, rendang, lemang, and Kuah kacang are some of the traditional Malay foods that Generation Z has highlighted as being trademark dishes of the Malay culture (Abdullah et al., 2021). However, identifying and acknowledging the food is not sufficient to gauge the skills and knowledge of Generation Z since the interest in cooking is still relatively low at this point. Moreover, Generation Z readily acknowledges that they have skills and knowledge gaps where it obviously resulted in them to be lack of knowledge and skills, similar to the previous studies findings (Suleiman et al., 2023; Azman et al., 2024). Even so, the young generation's interest in learning about traditional Malay food preparations is a remarkable outcome of this study that indicates the direction of learning acceptance. This reveals that Generation Z still values traditional foods despite the various circumstances that influence and impair their ability to prepare the food. According to Chukwurah et al. (2025), a strong of 'belonging' and a sense of pride are two factors that boost the chance that people would want to retain and preserve their cultural culinary traditions. As a consequence of this, the preservation of traditional culinary practices during festive events relies heavily on the engagement of today's younger generation. The older generation plays a pivotal role in nurturing this involvement by imparting cultural knowledge and reinforcing its value. (Kamaruzaman et al., 2022; Suleiman et al.,2023; Azman et al., 2024)

In conclusion, the minimal skills and knowledge that Generation Z possesses concerning Malay traditional food may still be developed, given that they have proved that they are prepared to learn. It is challenging to both maintain and evaluate cultural legacy due to the fact that it is intertwined with the norms, standards, practices, and beliefs of a society (Bahizalsah et al., 2022; Misran et al., 2022). Therefore, food knowledge transfer is the most effective ways for addressing the shortage of knowledge and skills among the younger generation (Aris et al., 2022; Suleiman et al., 2023). Despite of this, enhancing the skills and knowledge of younger generations helps to conserve traditional Malay dishes, which are currently among the most valuable forms of knowledge (Hashim et al., 2024; Azman et al., 2024; Mulok et al., 2025). Seconded by Mulok et. al (2025), a lack of knowledge in traditional culinary practices can hinder individuals, families, and communities from preparing nutritious and high-quality dishes. The implementation of Social Learning Theory by Bandura 1971, the theory suggests that individuals acquire knowledge by watching and interpreting the actions of those around them.

As a consequence of this, it is our responsibility to ensure that the skills and knowledge passed to our Generation Z become applicable in the process of preserving our Malay traditional food, particularly when it comes to the preparation of dishes for special occasions and festive. According to Immonen (2021) food holds memories and reflects the shared identity of one community, connecting it to others. To safeguard the continuity of heritage cuisine, it is crucial to comprehend and actively engage with the historical context, culinary techniques, recipes, and practical knowledge that shape its identity (Abdul Raji et al., 2022). The findings of this study will make an important contribution to the existing body of knowledge on traditional Malay cuisine as well as the gourmet literature of the globe in general. Hence, in addition, there have been limited recent comprehensive studies on the traditional Malay food skill and knowledge or perception of ready-to-eat and convenience Malay traditional food that specifically emphasize on new or young generation.

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POLITEKNIK KOTA KINABALU

Faktor-Faktor yang Mempengaruhi Niat untuk Membeli Produk Kitar Semula: Kajian dalam Kalangan Komuniti Kolej Komuniti Chenderoh

Zakina Izienty Zainal[1], Mohamad Afizan Bin Ali[2*], Mohd Zairulniza Bin Jaludin[3]

[1,2]Program Sijil Operasi Perhotelan, Kolej Komuniti Chenderoh, 33000 Kuala Kangsar, Perak, Malaysia
[3] Program Teknologi Elektrik, Kolej Komuniti Sungai Siput, 31100 Sungai Siput (U), Perak, Malaysia

zakina@kkche.edu.my

ABSTRAK

Kajian ini bertujuan mengenal pasti elemen-elemen utama yang mempengaruhi niat membeli produk kitar semula dalam kalangan warga Kolej Komuniti Chenderoh (KKCP), dengan menekankan tiga faktor utama iaitu kesedaran alam sekitar, tanggungjawab individu, dan norma peribadi. Isu pencemaran dan kemerosotan sumber semula jadi mendorong kepada kepentingan amalan kitar semula. Walaupun inisiatif seperti kempen 3R telah lama digalakkan di Malaysia, penglibatan masyarakat, termasuk institusi pendidikan, masih tidak menyeluruh. Kajian ini menggunakan pendekatan kuantitatif dengan melibatkan 119 responden. Data dianalisis melalui analisis regresi linear berganda dan ujian-t sampel bebas. Hasil analisis menunjukkan bahawa kesedaran terhadap kesan alam sekitar serta norma peribadi memberikan pengaruh signifikan terhadap niat membeli, manakala tanggungjawab peribadi tidak memberikan kesan yang ketara. Kajian turut mendapati bahawa jantina dan kumpulan umur tidak menunjukkan perbezaan yang signifikan. Dapatan ini menyarankan keperluan memperkukuhkan pendidikan alam sekitar dan memperkasa norma sosial dalam membentuk pengguna yang lebih bertanggungjawab. Kajian ini menyumbang kepada pemahaman lebih luas mengenai tingkah laku pengguna berkaitan kelestarian di institusi pendidikan.

Kata Kunci: *Kesedaran terhadap Akibat, Penetapan Tanggungjawab, Norma Peribadi, Niat untuk Membeli Produk Kitar Semula*

1. PENGENALAN & PENYATAAN MASALAH

Persekitaran semula jadi memainkan peranan penting dalam memastikan keseimbangan ekologi dan kelangsungan hidup pelbagai bentuk kehidupan. Sumber seperti air bersih, udara segar, makanan, dan perlindungan bergantung kepada kestabilan alam sekitar (ByJus, 2020). Namun begitu, kepesatan pembangunan dan perindustrian telah menyebabkan pelbagai aktiviti manusia menjejaskan keseimbangan ini. Pencemaran udara, air dan tanah, peningkatan populasi, pengurusan sisa yang lemah serta pelepasan gas rumah hijau adalah antara faktor utama penyumbang kepada kemerosotan alam sekitar (Aini et al., 2003).

Antara kesan utama yang sedang dihadapi termasuklah peningkatan jumlah sisa pepejal, pengurangan sumber semula jadi serta keperluan menambah tapak pelupusan sisa yang menjejaskan landskap dan biodiversiti. Sebagai salah satu usaha menangani isu ini, aktiviti kitar semula diperkenalkan bagi mengurangkan tekanan terhadap alam sekitar. Proses ini melibatkan pengumpulan dan pemprosesan semula bahan buangan seperti plastik, kertas, logam dan kaca kepada produk baharu yang boleh digunakan semula (Khalil et al., 2023).

Kitar semula bukan sahaja membantu mengurangkan jumlah sisa, malah turut menyumbang kepada penjimatan tenaga, pemeliharaan sumber semula jadi, dan menggalakkan gaya hidup lestari. Walaupun pelbagai kempen seperti kempen 3R telah dijalankan sejak sekian lama di Malaysia, tahap penglibatan masih belum mencapai sasaran yang diharapkan (Khair & Ahmad, 2017). Sebagai contoh, kadar kitar semula Malaysia pada tahun 2021 hanyalah sekitar 31.5%, jauh di bawah sasaran 40% menjelang 2025 serta lebih rendah berbanding negara-negara maju (Noor Azlina & Adam, 2022).

Kolej Komuniti Chenderoh (KKCP) turut mengambil inisiatif dalam mendidik komuniti mengenai kelestarian alam sekitar menerusi penyediaan kemudahan tong kitar semula dan program kesedaran seperti "Go Green". Namun begitu, pemerhatian mendapati tahap penglibatan masih rendah. Masih wujud kekangan dalam bentuk pengetahuan, sikap dan tingkah laku mesra alam.

Kajian lepas menunjukkan faktor seperti kesedaran terhadap kesan pencemaran, tanggungjawab moral dan norma sosial memberi kesan kepada amalan pengguna (Ajzen & Fishbein, 1980; Retno et al., 2019). Walaupun demikian, faktor ekonomi dan harga produk masih menjadi halangan kepada pembelian produk kitar semula (Pretner et al., 2021). Berdasarkan jurang ini, kajian ini memfokuskan kepada tiga faktor utama iaitu kesedaran terhadap akibat, tanggungjawab peribadi, dan norma peribadi dengan merujuk kepada pendekatan "Norm Activation Theory"(Schwartz, 1977). Kajian ini turut meneliti perbezaan niat membeli berdasarkan faktor demografi seperti jantina dan umur. Objektif kajian adalah:

i. Menilai kesan kesedaran terhadap akibat, tanggungjawab individu dan norma peribadi terhadap niat membeli produk kitar semula dalam kalangan komuniti KKCP.
ii. Menganalisis perbezaan niat membeli mengikut jantina dan kumpulan umur.

Dapatan kajian ini dijangka dapat membantu institusi dalam merangka strategi pendidikan alam sekitar yang lebih berkesan dan inklusif.

2. SOROTAN KAJIAN

2.1 Pengenalan

Sorotan ini mengupas faktor utama yang menyumbang kepada niat pengguna untuk membeli produk mesra alam, iaitu kesedaran terhadap akibat, tanggungjawab individu, dan norma peribadi. Kesedaran terhadap akibat merujuk kepada pemahaman individu tentang kesan perbuatan mereka terhadap alam sekitar. Semakin tinggi tahap kesedaran ini, semakin besar kecenderungan mereka untuk mengamalkan tingkah laku lestari. Tanggungjawab individu pula melibatkan kepercayaan bahawa seseorang itu perlu memainkan peranan dalam memelihara alam sekitar. Norma peribadi pula ialah dorongan dalaman yang terbentuk daripada nilai moral individu terhadap isu kelestarian. Ketiga-tiga unsur ini saling melengkapi dalam membentuk corak tingkah laku pengguna yang bertanggungjawab.

2.2 Kesedaran terhadap Akibat

Kesedaran alam sekitar dalam kalangan pengguna kian meningkat berikutan pendedahan kepada media, pendidikan dan pengalaman peribadi. Produk kitar semula yang direka untuk mengurangkan kesan negatif terhadap alam sekitar memerlukan pemahaman pengguna agar penerimaannya lebih meluas (Kong et al., 2014; Ogiemwonyi & Harun, 2020). Komunikasi pemasaran seperti label produk dan bahan promosi memainkan peranan penting dalam menyampaikan nilai dan manfaat produk hijau. Menurut beberapa kajian lepas, pengguna yang memahami kesan positif produk kitar semula terhadap kelestarian lebih cenderung untuk menyokong dan membelinya. Pendidikan pengguna serta pengalaman berinteraksi dengan maklumat berkaitan produk ini mampu memupuk tingkah laku mesra alam yang lebih konsisten (Ritter et al., 2015). Hipotesis pertama adalah seperti berikut:

H1: Kesedaran terhadap akibat memberi kesan kepada niat membeli produk kitar semula.

2.3 Penetapan Tanggungjawab

Tanggungjawab individu merujuk kepada tahap keprihatinan seseorang terhadap hasil perbuatan mereka terhadap persekitaran (Klockner, 2013). Apabila seseorang menyedari bahawa kelalaian terhadap amalan kelestarian boleh memberi kesan buruk kepada alam sekitar, mereka cenderung merasa terpanggil untuk mengambil tindakan. Tingkah laku pro-alam seperti membeli produk kitar semula sering dikaitkan dengan rasa tanggungjawab terhadap kesejahteraan bersama (Raza & Farrukh, 2023). Kajian menunjukkan bahawa apabila individu merasakan mereka sebahagian daripada penyelesaian, mereka lebih bersedia untuk menyokong amalan mesra alam walaupun melibatkan kos tambahan (De Groot & Steg, 2009). Oleh itu, hipotesis ini dibangunkan:

H2: Penetapan tanggungjawab individu mempengaruhi niat membeli produk kitar semula.

2.4 Norma Peribadi

Norma peribadi ialah kepercayaan moral yang mendorong seseorang bertindak secara lestari (Schwartz, 1977). Untuk norma ini teraktif, seseorang perlu menyedari kesan buruk sekiranya tiada tindakan diambil dan menerima tanggungjawab atas akibat tersebut (Wang et al., 2018). Individu yang mempunyai norma peribadi yang kuat biasanya menjadikan kelestarian sebagai nilai hidup dan mempengaruhi keputusan mereka dalam pembelian. Beberapa kajian (Fauzi et al., 2022; Wang et al., 2023; Doran & Larsen, 2016; Stern & Dietz, 1994) menunjukkan norma ini mempengaruhi pemilihan produk mesra alam termasuk pakaian kitar semula, hotel hijau, dan produk organik. Hipotesis yang ketiga adalah seperti berikut:

H3: Norma peribadi mempengaruhi niat membeli produk kitar semula.

2.5 Niat untuk Membeli Produk Kitar Semula

Niat membeli sering dijadikan petunjuk sama ada seseorang itu akan membuat pembelian dalam masa terdekat (Namias, 1959). Walaupun produk kitar semula menawarkan nilai alam sekitar, tidak semua pengguna bersedia membayar lebih jika dibandingkan dengan produk konvensional.

Faktor jantina dan umur juga dilihat sebagai pemboleh ubah yang mempengaruhi kecenderungan membeli. Kajian Maineri et al. (1997) menunjukkan wanita lebih cenderung terlibat dalam amalan hijau berbanding lelaki, manakala golongan muda biasanya lebih prihatin terhadap isu alam sekitar berbanding yang lebih berumur (Hamzaoui-Essoussi & Linton, 2014).

H4: Terdapat perbezaan niat membeli produk kitar semula berdasarkan jantina.

H5: Terdapat perbezaan niat membeli produk kitar semula berdasarkan umur.

3. METODOLOGI KAJIAN

Kajian ini menggunakan pendekatan kuantitatif bagi mengumpul dan menganalisis data berkaitan niat untuk membeli produk kitar semula dalam kalangan warga KKCP. Pendekatan

kuantitatif dipilih kerana ia mampu menyediakan data yang objektif, terperinci serta sesuai untuk menjalankan analisis statistik yang dapat menjawab objektif kajian dengan komprehensif.

3.1 Reka Bentuk Kajian dan Populasi

Kajian ini dijalankan secara kuantitatif bagi menilai faktor-faktor yang mempengaruhi niat membeli produk kitar semula. Kajian melibatkan warga Kolej Komuniti Chenderoh yang terdiri daripada pelajar, pensyarah, dan kakitangan pentadbiran. Pengumpulan data dilaksanakan secara dalam talian menggunakan borang soal selidik melalui platform seperti Google Forms. Kaedah ini dipilih kerana ia lebih efisien serta memudahkan capaian kepada responden dalam kalangan komuniti kolej.

3.2 Kaedah Persampelan

Kaedah pensampelan mudah (convenience sampling) telah digunakan dengan pendekatan 'snowball' bagi meningkatkan jumlah responden. Responden diminta mengedarkan soal selidik kepada rakan sekerja atau pelajar lain. Segala maklumat yang diperoleh dijamin kerahsiaan dan hanya digunakan untuk tujuan penyelidikan.

Saiz sampel ditentukan berdasarkan perisian G*Power dengan mengambil kira saiz kesan sederhana (0.15), aras signifikan 0.05 dan kuasa statistik 0.80. Anggaran minimum yang diperlukan ialah 74 responden, namun kajian ini telah berjaya mendapatkan 119 maklum balas, melepasi jumlah minimum yang dicadangkan bagi meningkatkan kebolehpercayaan hasil kajian.

3.3 Reka Bentuk Instrumen

Soal selidik kajian ini terdiri daripada tiga bahagian utama:

- Bahagian A: Maklumat demografi seperti umur, jantina dan status pekerjaan.
- Bahagian B: Item yang mengukur tahap kesedaran terhadap akibat, tanggungjawab peribadi dan norma peribadi.
- Bahagian C: Soalan berkaitan niat membeli produk kitar semula.

Item-item dalam soal selidik telah diadaptasi daripada kajian terdahulu oleh Hein (2022) dan disesuaikan dengan konteks tempatan. Kajian rintis telah dijalankan bagi menilai kebolehpercayaan instrumen menggunakan indeks Cronbach’s Alpha.

3.4 Kaedah Analisis Data

Data dianalisis menggunakan perisian SPSS versi 27. Analisis merangkumi:

- Statistik deskriptif bagi profil demografi responden.
- Analisis regresi linear berganda bagi menilai kesan faktor-faktor utama terhadap niat pembelian.
- Ujian-t sampel bebas (independent sample t-test) untuk menilai perbezaan berdasarkan jantina dan umur.

3.5 Ujian Kebolehpercayaan Instrumen

Nilai kebolehpercayaan (Cronbach's Alpha) bagi setiap konstruk adalah seperti berikut:

Jadual 2. Nilai *Cronbach's Alpha* bagi Kajian Rintis *(Cronbach's Alpha ≥ 0.70)*

Konstruk	Cronbach's Alpha
Kesedaran terhadap Akibat	0.726
Penetapan Tanggungjawab	0.865
Norma Peribadi	0.779

Kesemua nilai melebihi nilai 0.70, membuktikan bahawa item dalam soal selidik mempunyai kebolehpercayaan yang memuaskan dan sesuai digunakan dalam kajian sebenar.

4. HASIL DAPATAN / KEPUTUSAN

Sebanyak 119 respons telah diperoleh daripada pelajar, pensyarah dan kakitangan sokongan di KKCP. Setiap jawapan daripada borang soal selidik direkod secara sistematik dan disemak untuk menjamin ketepatan serta kesahan data. Setelah proses penyaringan selesai, data dianalisis menggunakan perisian SPSS versi 27. Analisis yang dijalankan meliputi statistik deskriptif dan inferensi, dengan tujuan utama untuk menjawab persoalan kajian, mengenal pasti hubungan antara pemboleh ubah serta menilai perbezaan yang signifikan berdasarkan ciri demografi responden.

4.1 Analisis Demografi Responden

Kajian ini berjaya memperoleh sebanyak 119 respons daripada pelbagai kelompok dalam kalangan komuniti KKCP yang terdiri daripada pelajar, pensyarah, dan staf sokongan. Data dikumpulkan menerusi soal selidik dalam talian dan dianalisis menggunakan perisian SPSS versi 27. Analisis melibatkan pendekatan deskriptif untuk mengenal pasti profil peserta serta analisis inferensi bagi menguji hubungan antara pemboleh ubah dan pengaruh faktor demografi terhadap niat membeli produk kitar semula. Keputusan adalah seperti berikut:

Jadual 3. Analisis Demografi Responden

Pembolehubah	**Kategori**	**Responden**	
		***N* = 119**	**%**
Jantina	Lelaki	60	50.4
	Perempuan	59	49.6
Umur	Kumpulan Lebih Muda (bawah 40 tahun)	83	69.7
	Kumpulan Lebih Berusia (40 tahun dan ke atas)	36	30.3
Kategori Profesion	Pensyarah	21	87.1
	Kakitangan Pengurusan	8	6.7
	Kakitangan Pentadbiran	10	1.3
	Pelajar	80	4.9

Dari segi jantina, bilangan responden lelaki dan perempuan adalah hampir seimbang, dengan 60 orang lelaki (50.4%) dan 59 orang perempuan (49.6%). Bagi aspek umur, sebahagian besar peserta kajian iaitu 83 orang (69.7%) berada dalam kategori umur bawah 40 tahun, manakala 36 orang lagi (30.3%) berumur 40 tahun ke atas. Dalam kategori pekerjaan pula, majoriti terdiri daripada pelajar dengan jumlah 80 orang (67.2%), diikuti oleh 21 pensyarah (17.6%), 10 kakitangan pentadbiran (8.4%) dan 8 kakitangan pengurusan (6.7%).

Secara keseluruhan, pola agihan ini menunjukkan bahawa golongan muda, khususnya pelajar, merupakan kumpulan paling dominan dalam kajian ini. Hal ini memberi gambaran bahawa perspektif dan kecenderungan generasi muda terhadap isu kelestarian dan amalan pembelian produk kitar semula memainkan peranan yang signifikan dalam hasil kajian yang diperoleh.

4.2 Analisis Faktor yang Mempengaruhi Niat Membeli Produk Kitar Semula

Analisis regresi linear berganda telah dijalankan untuk mengenal pasti hubungan antara tiga pemboleh ubah bebas iaitu kesedaran terhadap kesan alam sekitar, tanggungjawab individu dan norma peribadi terhadap pemboleh ubah bersandar iaitu niat membeli produk kitar semula.

Dapatan menunjukkan bahawa terdapat hubungan yang signifikan antara dua daripada tiga pemboleh ubah bebas dengan niat pembelian, seperti yang dijelaskan di bawah.
Nilai pemalar (constant) dalam model adalah signifikan secara statistik ($t = 2.636$, $p = 0.010$), yang menunjukkan wujudnya kecenderungan asas untuk membeli produk kitar semula walaupun tanpa pengaruh langsung daripada pemboleh ubah bebas yang dikaji. Kesedaran terhadap kesan alam sekitar didapati memberi impak yang positif dan signifikan terhadap niat pembelian ($\beta = 0.384$, $t = 4.935$, $p < 0.001$), yang bermaksud semakin tinggi tahap kesedaran, semakin besar keinginan untuk membeli produk berasaskan kitar semula. Sebaliknya, tanggungjawab peribadi tidak menunjukkan hubungan yang ketara dengan niat membeli ($\beta = -0.076$, $t = -1.139$, $p = 0.257$), menandakan bahawa rasa tanggungjawab semata-mata mungkin tidak mencukupi untuk mendorong pembelian produk tersebut. Norma peribadi muncul sebagai faktor yang paling kuat mempengaruhi niat ($\beta = 0.547$, $t = 8.589$, $p < 0.001$), sekali gus menekankan bahawa nilai moral dan kepercayaan peribadi memainkan peranan penting dalam membuat keputusan pembelian lestari. Secara keseluruhan, model regresi ini adalah signifikan ($F = 59.940$, $p < 0.001$), dan menunjukkan bahawa gabungan ketiga-tiga pemboleh ubah bebas menyumbang sebanyak 61% daripada variasi niat pembelian ($R^2 = 0.610$). Ini menandakan model mempunyai keupayaan penjelasan yang baik.

Kesimpulannya, keputusan analisis menunjukkan bahawa norma peribadi dan kesedaran terhadap kesan alam sekitar merupakan faktor utama yang meramalkan niat untuk membeli produk kitar semula. Sebaliknya, tanggungjawab individu tidak memberikan kesan langsung yang signifikan. Oleh itu, usaha meningkatkan kesedaran awam dan pembinaan nilai moral berkaitan kelestarian alam sekitar adalah lebih berkesan berbanding hanya menekankan rasa tanggungjawab peribadi semata-mata.

Jadual 4: Analisis Regresi Linear Berganda

Coefficients[a]

Independent Variable	*Beta*	*t*	*Sig.*
Constant		2.636	0.010
Kesedaran Terhadap Akibat	0.384	4.935	0.000
Penetapan Tanggungjawab	-0.076	- 1.139	0.257
Norma Peribadi	0.547	8.589	0.000
Predictors: Niat			

Model Summary

Model	*R*	*R Square*	*Adjusted R Square*	*Standard Error of the Estimate*
1	.781[a]	.610	.600	.39257
a Predictors: (Constant), KESEDARAN, TANGGUNGJAWAB, NORMA				

ANOVA[a]

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig*
1	Regression	27.713	3	.9.238	59.940	.000[b]
	Residual	17.723	115118	.154		
	Total	45.436				

4.3 Analisis Perbezaan Niat Berdasarkan Jantina

Jadual 5 mempersembahkan hasil analisis Ujian-t Sampel Bebas yang dijalankan bagi menilai perbezaan purata skor niat membeli produk kitar semula berdasarkan jantina, iaitu antara responden lelaki dan perempuan. Ujian Levene's bagi kesaksamaan varians menunjukkan nilai F = 0.090 dengan p = 0.765, yang melebihi paras signifikan 0.05. Ini menandakan bahawa varians antara kedua-dua kumpulan adalah setara, maka keputusan ujian-t diambil berdasarkan andaian “Equal variances assumed”.

Hasil ujian menunjukkan nilai t = 0.244 dengan darjah kebebasan (df) sebanyak 117 dan nilai p = 0.808 (p > 0.05), menunjukkan tiada perbezaan signifikan secara statistik dalam min niat pembelian antara lelaki dan perempuan. Perbezaan min yang dicatatkan adalah 0.2787 dengan ralat piawai sebanyak 0.11423, menunjukkan perbezaan yang kecil dan tidak bermakna. Di samping itu, julat selang keyakinan 95% yang berada antara -0.1983 hingga 0.2541 merangkumi sifar, sekali gus menyokong dapatan bahawa tiada perbezaan ketara berdasarkan jantina dalam konteks ini.

Jadual 5: Ujian-t Sampel Bebas (Kumpulan Jantina)

	Levene's Test for Equality variances		t-test of Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
NIAT								Lower	Upper
Equal variances assumed	0.090	.765	0.244	117	0.808	0.2787	0.11423	-0.1983	0.2541
Equal variances assumed			0.244	112.739	0.808	0.787	0.11440	-0.1988	0.2545

4.4 Analisis Perbezaan Niat Berdasarkan Kumpulan Umur

Jadual 6 memaparkan hasil Ujian-t Sampel Bebas yang digunakan untuk menilai perbezaan purata skor niat membeli produk kitar semula berdasarkan kategori umur, iaitu antara individu yang berumur bawah 40 tahun dan mereka yang berumur 40 tahun ke atas. Keputusan Levene's Test menunjukkan nilai p = 0.900 (p > 0.05), menandakan bahawa varians antara kedua-dua kumpulan adalah seragam. Oleh itu, analisis diteruskan berdasarkan andaian "Equal variances assumed".

Jadual 6: Ujian-t Sampel Bebas (Kumpulan Umur)

	Levene's Test for Equality variances		t-test of Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
NIAT								Lower	Upper
Equal variances assumed	0.016	.900	-1.191	117	0.236	-0.1473	0.12362	-0.3921	0.9756
Equal variances assumed			-1.296	81.612	0.199	-0.1473	0.11366	-0.3734	0.07887

Nilai t yang diperoleh adalah -1.191 dengan tahap signifikan p = 0.236, yang melebihi nilai ambang 0.05. Ini menunjukkan tiada perbezaan yang ketara dari segi niat membeli produk kitar semula antara kumpulan umur muda dan kumpulan umur lebih berusia. Perbezaan purata antara kumpulan umur adalah -0.1473, manakala julat selang keyakinan 95% adalah di antara -0.3921 hingga 0.9756, yang meliputi nilai sifar. Dapatan ini mengesahkan bahawa perbezaan yang wujud adalah kecil dan tidak signifikan secara statistik.

5. KESIMPULAN DAN KEPENTINGAN KAJIAN

Kajian ini memberikan gambaran yang jelas mengenai faktor-faktor yang mendorong niat pembelian produk kitar semula dalam kalangan komuniti Kolej Komuniti Chenderoh (KKCP). Tumpuan diberikan kepada elemen kesedaran terhadap alam sekitar, rasa tanggungjawab individu, dan norma peribadi. Dapatan kajian mengesahkan bahawa kesedaran terhadap isu alam sekitar serta pematuhan terhadap nilai dan norma sosial menjadi pemangkin utama yang mempengaruhi kecenderungan untuk membeli produk berasaskan kitar semula. Penemuan ini mengukuhkan kepentingan membina kesedaran dan menanam nilai tanggungjawab sosial sebagai strategi ke arah pembentukan pengguna yang lebih prihatin terhadap kelestarian.

Salah satu dapatan menarik ialah pengaruh faktor penetapan tanggungjawab yang didapati tidak signifikan. Ini menunjukkan bahawa walaupun individu peka terhadap isu pencemaran alam sekitar, mereka mungkin tidak merasakan tanggungjawab peribadi untuk mengatasinya. Maka, terdapat keperluan untuk merancang pendekatan yang lebih berfokus bagi meningkatkan persepsi tentang peranan individu dalam menangani masalah alam sekitar.

Di samping itu, hasil analisis juga mendapati bahawa tiada perbezaan ketara dalam niat pembelian berdasarkan jantina mahupun umur. Hal ini menunjukkan bahawa faktor demografi bukanlah penentu utama dalam tingkah laku pembelian produk lestari. Oleh itu, strategi promosi dan intervensi seharusnya tidak terhad kepada kumpulan umur atau jantina tertentu, sebaliknya perlu memfokuskan kepada pengukuhan kesedaran dan nilai sosial yang berkaitan dengan amalan mesra alam.

Secara keseluruhannya, kajian ini mencadangkan agar intervensi yang dibangunkan untuk meningkatkan amalan kitar semula memberi tumpuan kepada pendidikan alam sekitar dan pembentukan norma sosial yang positif. Pendekatan berasaskan kesedaran dan nilai sosial ini lebih berpotensi mempengaruhi niat dan tingkah laku pengguna secara menyeluruh berbanding strategi yang bergantung kepada ciri demografi. Dengan tumpuan yang tepat, usaha ini dapat menyumbang kepada pencapaian matlamat pembangunan lestari dalam kalangan masyarakat kampus dan komuniti amnya.

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The Impact of Family, Peers, and Institutions' Support on Students' Entrepreneurial Intention

Clayrina Julianus[1*], Jean Jabilles[2]

[1,2,] Department of Tourism and Hospitality, No. 4, Jalan Politeknik, KKIP Barat, Kota Kinabalu Industrial Park, Politeknik Kota Kinabalu, 88460 Kota Kinabalu, Sabah.

*Corresponding author's email: clayrina@polikk.edu.my

Abstract

Entrepreneurship plays a crucial role in Malaysia's economic development, supported by government initiatives such as financial platforms, infrastructure development, and business consulting services. This study was conducted to identify the impact of family, peer, and institutional support on entrepreneurial intentions among students. Although the entrepreneurial intentions of students in higher education institutions have been studied from various perspectives, the results of the studies are not consistent, and the mechanisms and results related to how entrepreneurial intentions can be influenced by different factors require continuous research, which has prompted this study to examine the effects of family support, peers and institutions on entrepreneurial intentions among students. A total of 186 respondents from Semester 1 to Semester 6 students from Tourism and Hospitality Department were involved. Quantitative methods used were data collected through online questionnaires, which were distributed via Google Forms, and SPSS software was used to analyse the research data. The results show that the level of entrepreneurial intention in students is at a moderately high level, with a mean score value of 3.86. The multiple regression analysis was used to tested the hypothesis in this study. Findings show that entrepreneurial intentions are strongly influenced by family, peer, and institutional support. The findings of the study guide institutions and families to identify the level of entrepreneurial intention of students and then plan methods to increase the intention of students to become entrepreneurs. To obtain more extensive and clear research findings, the scope of the study is suggested to be expanded to all polytechnic institutions and community colleges by considering other factors that can influence the entrepreneurial intention of students.

Keywords: *entrepreneurial intention; family support; peers' support; institution's support*

1. Introduction

Entrepreneurship is essential for promoting upward mobility, social integration and economic growth, and serves as a successful method to reduce job pressure and create economic changes through bright achievement, particularly in the face of global economic pressure, Gao & Qin (2022). This is supported by Jena (2020), which mentions that entrepreneurship is becoming more widely acknowledged in many nations as an effective approach for boosting competitiveness and productivity, generating job opportunities, raising living standards, and as well as accomplishing collective objectives. Since it has a major impact on social and economic development, creates jobs and boosts market innovation, and is more competitive, the young generation should be exposed to entrepreneurship activity and the necessary skills from a young age to foster the mindset or spirit for future business ventures.

In Malaysia, the government has taken a variety of programs to support and empower more entrepreneurs, particularly Bumiputera, to drive the nation's economy, and one of Budget 2023's primary focal areas is covering the development of business and entrepreneurship-related project initiatives (Nor Yazmi et al., 2024; Ministry of Finance Malaysia, 2023). The government has taken the initiative to encourage students to explore and participate in entrepreneurship as aimed to foster a culture of entrepreneurship (Musa et al., 2023).

Since entrepreneurship is one of the key drivers in helping the nation address its social and economic problems, it becomes a focal point in Malaysia's educational system (Nor Yazmi et

al., 2024), and the process of entrepreneur education can begin as early as primary school. Hence, it is important to understand the factors that influence a person's intention to be an entrepreneur at an early stage for better alignment of training, mentorship, aspiration, and influence their commitment towards an entrepreneurial career. This study was conducted to identify the impact of family, peer, and institutional support on entrepreneurial intentions among students. Although the entrepreneurial intentions of students in higher education institutions have been studied from various perspectives, the results of the studies are not consistent, and the mechanisms and results related to how entrepreneurial intentions can be influenced by different factors require continuous research, which has prompted this study to examine the effects of family support, peers and institutions on entrepreneurial intentions among students in this institution. The research objective is to highlight the impact of family, peers, and institutional support on student entrepreneurial intention, which is beneficial for policymakers, educators, or universities in promoting entrepreneurial education and preparing students for high value in the future.

2. Literature Review

2.1 Entrepreneurial Intention

In the past few years, a noticeable increase in research on how role models affect the entrepreneur (Abbasianchavari & Moritz, 2021). As highlighted in research by Shahzad et al. (2021), pursuing entrepreneurial intentions or establishing a new business is motivated by individuals' self-interest and refers to an individual's self-acknowledged to start their own new business as well as purposely plan to do so in the future. Entrepreneurship intentions are strongly influenced by national cultures, entrepreneurial contexts that will mold entrepreneurship archetypes about what makes an entrepreneur, and the impact of role models from a young age; these factors rely on the would-be entrepreneurs' characteristics as well as influence by entrepreneurship education that they obtain from a young (Porfírio et al., 2023).

According to Nurjanah & Harsono (2024), refer to entrepreneurial intention is the determination to start own business or pursue entrepreneurship, and plans to behave in an entrepreneurial manner as part of entrepreneurial intention. Teenagers' aspiration and their decision to start their own business is influenced by social support from their family, close friends, and teachers (Khayru et al., 2021). Additionally, the same authors underlined that teenagers will feel encouraged and strengthened to be interested in being an entrepreneur with the support of family, teachers, and close friends. A study by Georgescu & Herman, E (2020) in their research found that the entrepreneurial competencies of students and their aspiration to follow this career were boosted by formal and informal education, which was received from parents who are entrepreneurs, and from institutions. This study is almost consistent with the studies by Shazad et al. (2021), which indicate that entrepreneurial intention is positively and significantly impacted by self-motivation, support from family, peer influence, and institutional support.

2.2 Family support

Families and parents have an impact on individual members' career choices through their emotional and behavioral responses (Ahmed, 2022). Family support is instrumental and effective encouragement to individuals that enhances individuals' feelings related to the intention to launch a business, and their support can convince someone to pursue

entrepreneurial efforts (Bataragoa et al., 2020). Family support is a main contributor that might encourage students to become more optimistic in running a business (Halizah & Mardikaningsih, 2022). Students from a particular background appear to be more optimistic about their resources and abilities to pursue an entrepreneurial career since they inherited the business environment, which may influence their future career intentions (Georgescu & Herman, 2020).

Georgescu & Herman, (2020) in their research finding indicate that the students from entrepreneurial families gain benefits from informal education and exhibit higher entrepreneurial intention starting their own business than the students from non-entrepreneurial families. These findings align with the result of Shahzad et al., (2021) study, which shows that family support is a significant factor that plays an influential role in boosting the entrepreneurial intention of individuals. However, Annisa et al. (2021) study discover that most dominant contribution of entrepreneurial intentions among students is driven by internal factor of locus of control compared to family support. In light of the literature review, the following hypothesis is proposed.

H_1: There is a significant impact of family support on students' entrepreneurial intention

2.3 Peer support

Children at the same age and developmental stage are called peers, and peers' role is to promote social development, including being friends, providing physical support, boosting ego, and fulfilling the roles of affection and social comparison (Nurjanah & Harson, 2024). Peer groups are frequently seen as a social environment that influences an individual's behaviour (Narmaditya & Wibowo, 2021), and peer influence is the pressure when a group of peers pressures an individual to shift or adapt certain ideals or desires. Research conducted by Shahzad et al. (2021), peer social power is also acknowledged as positively impacting on a student into an entrepreneurial transformation. Additionally, peers who are knowledgeable and interested in entrepreneurship offer meaningful guidance and motivational support, which increases students' preparedness to engage in entrepreneurial activity (Indradewa & Setiawan, 2024).

The study outcome, which was conducted by Shahzad et al., (2021) shows that peer influence had a positive and significant effect on young entrepreneurs' intention to pursue entrepreneurship, and they also highlight that the social power of peers positively affected on students' entrepreneurial transformation. Similar positive findings have been found in other studies by Kehinde & Afolabo (2024) showed a significant positive relationship between peer influence and entrepreneurial intention among undergraduates in South West, Nigeria. However, another study by Nurjanah & Harsono, 2024) shows opposite findings, which indicate that peer influence has no significant impact on entrepreneurial intentions. Based on insight from the literature review, the following hypothesis is proposed.

H_2: There is a significant impact of peer support on students' entrepreneurial intention

2.4 Institutions support

This study also intends to determine how far the support from institutions is able to shape students' entrepreneurial intentions. Notably, most previous studies we found demonstrate a positive contribution by institutions in influencing and enhancing students' entrepreneurial intent. A study by Anjum et al. (2020) believes that universities are a great place to foster students' entrepreneurial passion, and it is important to find out how much universities or

institutions are able to influence students' intention to be entrepreneurs. Based on an empirical study, entrepreneurial preferences are positively influenced by universities' entrepreneurship education, climate, legislation, finances, and other support as well (Lu et al., 2021). To achieve all this, events such as conferences and seminars with business owners, company visits, entrepreneurship-related prize competitions, and calls (for example, awards given upon their study completion), hosting competition for entrepreneurs within and with other institutions able to promote an entrepreneurial mindset and extend their knowledge (Barba- Sánchez et al., 2022).

Entrepreneurship development has benefited greatly from entrepreneurial education (Su et al., 2021) support such as lectures, training, and courses able to college students in learning about entrepreneurship, besides building up their entrepreneurial knowledge, abilities, and skills (Lu et al., 2021). Earlier study by Bataragoa et al. (2020) supported that study and quoted that the development of entrepreneurial abilities is aided by entrepreneurship education, which also includes resources and activities for starting own business. The same authors underlined the fact that entrepreneurial education is able to strengthen students' knowledge, creativity, and competence. Positive findings have been reported in the paper from Nurjanah & Harsono (2024), which indicate that entrepreneurship education significantly influences entrepreneurial intention, where indicate that the stronger the entrepreneurship education student receive, the greater their intention toward entrepreneurship. The opposite result was found in a study by Kusumojanto et al. (2021) found that the sample of respondents did not perceive entrepreneurship education as encouraging their entrepreneurial intentions. Based on the literature review, the following hypothesis is proposed.

H_3: There is a significant impact of institutional support on students' entrepreneurial intention

The study investigates the impact of family, peers, and institutions' support on students' entrepreneurial intention. A research framework was established to achieve the objective. The framework is as Figure 1.

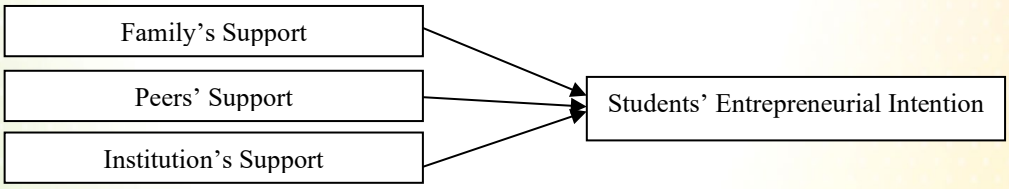


Fig.1. Research Framework

3. Methodology

The study utilized a quantitative method and Google Form was used to distribute the questionnaire to collect respondents' data. The respondents consist of students of Tourism & Hospitality students at Politeknik Kota Kinabalu with a total of 355 student. The sample size was determined using the Krejcie and Morgan (1970) table. A total of 186 students were needed for this study. The questionnaire is adapted from previous studies and consists of two sections. Section A assesses the respondents' profile, while Section B is divided into four parts that evaluate students' entrepreneurial intentions, family support, peer support, and institutional support. The items for entrepreneurial intentions has been adapted from Linan (2009), family support from Osorio et al. (2017), peer support from Koch et al. (2015), and institutional support from Saeed et al. (2018). Before final data collection, the questionnaire was piloted with 30 students to assess the validity of the measurement items and the expected reliability of the data collected. The Cronbach's alpha coefficients demonstrated that the item family, peers,

institutions, and entrepreneurial intention scales achieved high reliability with the Cronbach alpha values above 0.7 (Nunnally, 1978). A 5-point Likert scale was used to record respondents' feedback. To To conduct an analysis of the data that has been collected, Statistical Package for Social Science (SPSS) Version 29 have been utilised for descriptive analysis, reliability test (Cronbach's Alpha), correlation and multiple regression analysis.

4. Result

The analysis of the respondents in Table 1 below indicates that 96 of them are male students (48.4%) and 90 female (51.6%). In terms of field of study, 96 students or 51.6% of the sample are from Diploma in Resort Management followed by 77 students (41.4%) from the Diploma in Hotel Management and 13 students (7.0%), from *Sijil Kemahiran Hotel dan Katering*. Majority of respondents were in Semester 2, accounting for 55 students (29.6%), followed by 36 students (19.4%) in Semester 4. Semesters 5 and 3 had 29 (15.6%) and 25 (13.4%) students respectively, while Semester 1 had 26 students (14.0%), and Semester 6 had the minimum number of respondents, with only 15 students (8.1%).

Table 1. Respondent Profile

Demography	Category	Number of students	Percentage %
Gender	Male	96	48.4
	Female	90	51.6
Field of Study	Diploma in Hotel Management	77	41.4
	Diploma in Resort Management	96	51.6
	Sijil Kemahiran Hotel dan Katering	13	7.0
Semester	1	26	14.0
	2	55	29.6
	3	25	13.4
	4	36	19.4
	5	29	15.6
	6	15	8.1

Table 2 shows the reliability of the construct of this study. A construct is reliable if the Alpha (α) value is greater than 0.70 (Hair et al., 2013). Construct reliability was measured using Cronbach's Alpha. The results shows that that Family support (five items, α = .733), Peer support (four items, α = .867), and Institutional support (six items, α = .892) were proven to be reliable. Similarly, the Entrepreneurial Intention scale with six items is also found to be reliable (α = .809).

Table 2. Reliability Statistic

Construct	No. of Item	Alpha (α)
Family's Support	5	.733
Peer' Support	4	.867
Institution's Support	6	.892
Entrepreneurial Intention	6	.809

The data in Table 3 explain the descriptive statistics of the total mean scores and standard deviations of four variables. The result shows that institution support achieved the highest mean score (M = 4.02, SD = .591), followed by peer support (M = 4.00, SD = .640) and family support (M = 3.98, SD = .671). The mean score for students' entrepreneurial intentions is M=3.06, SD = 0.67. This indicates that even though students receive some support from their institution, friends, and family, their entrepreneurial intention moderate level.

Table 3. Descriptive Statistics for Support Variables and Entrepreneurial Intention

Item	Total Mean Score	Std. Deviation	Level
Family Support	3.98	.671	Medium High
Peer Support	4.00	.640	Medium High
Institution Support	4.02	.591	High
Entrepreneurial Intention	3.06	.670	Medium High

Note: Mean Score Interpretation by Nunnally and Bernstein (1994)

A Pearson correlation analysis was used to investigate the relationship between the independent and dependent variables. The result in table 4 indicates that peer support demonstrated the strongest positive correlation ($r = .733$, $p < .01$) with entrepreneurial intention, followed by institutional support ($r = .649$, $p < .01$) and family support ($r = .575$, $p < .01$). These findings confirm the research framework and justify proceeding with the multiple regression analysis.

Table 4 Pearson Correlation Matrix

	Family Support	Peer Support	Institution Support	Entrepreneurial Intention
Family Support	1			
Peer Support	.613**	1		
Institution Support	.635**	.720**	1	
Entrepreneurial Intention	.575**	.733**	.649**	1

**. Correlation is significant at the 0.01 level (2-tailed)

A multiple regression analysis was used to investigate the effects of Family Support (FS), Peer Support (PS), and Institutional Support (IS) on Entrepreneurial Intention (EI). The result in Table 5 shows that the independent variable significantly predicts entrepreneurial intention $F(3, 181) = 82.720$, $p < .001$, which indicates that the three factors have a significant impact on entrepreneurial intention. The $R^2 = .578$ indicates that the model explains 57.8% of the variance in entrepreneurial intention. In addition, coefficients were further measured to determine the influence of each of the factor on entrepreneurial intention. The results show that family support has a significant effect on EI ($B = .141$, $t = 2.155$, $p = .032$), therefore supporting H1. Peer support shows a significant positive effect on entrepreneurial intention ($B = .529$, $t = 6.940$, $P < .001$). Therefore, H2 is also supported. H3 examines whether institutional support has a significant impact on entrepreneurial intention. The findings indicate that institutional support has a positive effect on entrepreneurial intention ($B = .222$, $t = 2.638$, $p = 0.009$). Therefore, H3 is supported. The result shown in Table 5. To check for multicollinearity, the VIF value is examined for each factor. Multicollinearity occurs when independent variables in a study are strongly correlated (Hair et al., 2017). The result in Table 5 confirms that the VIF values for each of the variables are below 5, which indicate that multicollinearity does not present in this study.

Table 5. Multiple Regression Analysis

Hypotheses	Regression predictor	B	t	P - Value	Decision	VIF
H1	**FS -> EI**	.141	2.155	.032*	Supported	1.831
H2	**PS -> EI**	.529	6.940	.001*	Supported	2.272
H3	**IS -> EI**	.222	2.638	.009*	Supported	2.373
R	.578					
F (3, 181)	82.720					

Note. *p<0.05. EI: Entrepreneurial Intention, FS: Family's Support, PS: Peers' Support, IS: Institution's Support

5. Discussion

The purpose of this study is to investigate how family, peer, and institutional support influences students' entrepreneurial intentions. The findings of this study confirm the hypothesis, indicating that family, peers, and institutional support significantly affect students' entrepreneurial intention. Consistent with findings by Bataragoa et al. (2020) and Georgescu & Herman (2020), family is one of the motivating factors that shape entrepreneurial intention by offering emotional, informational, and instrumental support. Families not only providing inspiration and motivation, but also act as informal educators, particularly in those cases where students are brought up in an entrepreneurial family. These students tend to develop greater confidence and a more optimistic outlook towards entrepreneurship (Halizah & Mardikaningsih, 2022; Georgescu & Herman, 2020).

Peer support also has a significantly impact on entrepreneurial intention. The findings of this study are consistent with previous research by Indradewa & Setiawan (2024) and Kehinde & Afolabi (2024), which reveals that peer groups serves as a important influence during the formative years of students. Circle of friends with similar interests in entrepreneurship play a role not only in giving motivation but also sharing knowledge and emotional support, which in turn contributes to the development of student entrepreneurship. Social networks among peers have also encouraged risk-taking and exploration of entrepreneurship. Institutional support also significantly influence students' entrepreneurial intentions. This finding is consistent with previous studies by Lu et al. (2021) and Su et al. (2021), which discovered that the institutional environment, through coordinated and structured entrepreneurship education and supporting infrastructure, plays an important role in fostering an entrepreneurial mindset. Institutions that provide entrepreneurship related programs, such as seminars, training, and competitions, offer students both the theoretical foundation and practical experience necessary to pursue entrepreneurial ventures (Barba-Sánchez et al., 2022). The results emphasize the importance of institutions in providing the students with the skills they need to move from intention to action. The findings of this research on the level of entrepreneurial intention shows that a relatively high level of entrepreneurial intention which coincides with Malaysia's national strategy to promote entrepreneurship among youth thereby attracting more students to engage in entrepreneurship after graduation (Nor Yazmi et al., 2024; Musa et al., 2023). This study emphasizes the importance of family, peer networks, and institutions in fostering entrepreneurial growth among future graduates.

6. Conclusion

The finding shows that family support, peers, and institutional support all play significant roles in shaping students' entrepreneurial intentions. When students surrounded by supportive peers who consistently provide motivation, along with ongoing support from family and academic support from institutions, it will further enhance their intention to venture in entrepreneurship. As Malaysia emphasizes on entrepreneurship as a driver of economic growth and encourage students to be an entrepreneur, understanding these factors is crucial for developing effective policies and educational program to motivate students to venture in entrepreneurship. This research has its own limitation whereby this study is it only focuses on students from Politeknik Kota Kinabalu specifically from Department of Tourism and Hospitality. For future research, conducting a broader analysis which includes various educational institutions and assessing different psychological variables as well as broader factors will help provide a more comprehensive understanding of what motivates students' entrepreneurial goals, thus strengthening their intentions to pursue entrepreneurship.

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