Journal of Information System and Technology Management
JISTM
EISSN: 0128-1666
Volume 11 Issue 42 (March 2026) PP. 78-92

JOURNAL OF INFORMATION SYSTEM AND TECHNOLOGY MANAGEMENT (JISTM)
www.gaexcellence.com/jistm

INTEGRATION OF ARTIFICIAL INTELLIGENCE (AI) IN SHAPING USER INTERFACE (UI) AND USER EXPERIENCE (UX) IN MOBILE PACKAGING DESIGN: iDPAC APPS

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Article Info:

Article history:
Received date: 17.06.2025
Revised date: 10.07.2025
Accepted date: 29.01.2026
Published date: 02.03.2026

To cite this document:

Adnan, N. (2026). Integration Of Artificial Intelligence (AI) In Shaping User Interface (UI) And User Experience (UX) In Mobile Packaging Design: iDPAC Apps. *Journal of Information System and Technology Management, 11* (42), 78-92.

DOI:10.35631/JISTM.1142005

Abstract:

Intelligence Digital Packaging (iDPAC) is a digital integration of artificial intelligence (AI) in mobile applications' user interface and user experience (UX) design modules. This approach addresses the lack of educational resources and samples in packaging design, leading to unrealistic designs. The study focuses on AI in UI and UX mobile app prototypes and packaging design processes to optimize its advantages in the creative design industry. The qualitative methodology involves observation and interviews with educators, learners, and industry experts to gather insights on potential improvements in AI integration in UI and UX mobile apps. The study uses Design Developmental Research (DDR) and Design Thinking (DT) frameworks to discover user needs, design prototypes, and test them with real users. The DDR-DT framework has effectively facilitated the development of mobile apps that meet user satisfaction in packaging design.

Keywords:

AI, Design Developmental Research, Design Thinking, UI and UX Mobile App, Packaging Design

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Introduction

AI is opening new possibilities for creative expression despite the inherent challenges. However, the AI approach in the ideation design process lacks the simulation of the sense of creativity and diminishes human capabilities in solving design challenges (Ardhianto & Nababan, 2023). In the realm of design, AI can generate novel concepts based on existing designs or recognise new combinations of materials and technologies by aiding designers in simulating ideation and concepts to swiftly identify and refine the most promising ideas (Hughes, 2021). Nevertheless, the potential benefits and applications of AI in the early stages of the creative process remain largely unexplored (Stoimenova & Price, 2020). Therefore, Sandesara et al. (2022) note that developers struggle to meet user expectations and engage users effectively due to poor UI design choices. Furthermore, inadequate UX can result in user frustration and low retention rates (Bothma, 2023). Consequently, it is vital for developers to prioritise user-centred design principles to create successful mobile applications. When users become confused and frustrated with an app, it can lead to a negative overall experience (Yablonski, 2024). By focusing on intuitive navigation, clear visual hierarchies, and seamless interactions, developers can significantly enhance the usability and appeal of their mobile apps, ultimately resulting in higher user satisfaction and increased retention rates. Conventional mobile apps frequently depend on static UI design that fail to accommodate different user preferences, customs and usage behaviours. This obstacle leads to decreasing user involvement and inefficiency for making decisions. The incorporation of AI solves these challenges by facilitating adaptable, based on data and individualised UI and UX engagement experiences. This research focuses on a packaging design module as a reference sample for developing mobile prototype design. Due to insufficient time for students to complete the packaging design and frequently inappropriate guidelines in conventional teaching and learning, communication breakdowns between students and educators occur during the explanation of the packaging design process (Zaryabi & Abeddoost, 2022). This is particularly challenging as learners are frequently new to the field and may not grasp the constraints of visual elements in packaging design, such as functionality, cost-effectiveness, and sustainability. Hence, the potential of AI could assist educators and learners in understanding the basic principles of packaging design or in testing their designs with real users to obtain feedback on usability and functionality (Sluÿters et al., 2022). AI can support designers in generating new and innovative ideas, and it can also aid in refining their designs to enhance visual appeal (Milosevic, 2023), allowing users to quickly sample concepts that could be viable. The advantage of AI lies in its capability as a powerful tool for creating packaging designs that are both creative and effective for designers, educators, manufacturers, and consumers (Ijaz, 2023). In connection with this research, the aim is to develop a mobile app prototype design for packaging design modules, leveraging AI concepts as supportive tools to improve and enhance the quality of teaching and learning through mobile learning experiences, fostering better understanding both within and outside the classroom. The objectives of this research are to identify the features of UI and UX in mobile apps in educational environments, to define the elements of packaging design and to develop the mobile apps to enhance the quality of teaching and learning incorporating AI as supporting. Although its benefits, the incorporation of AI in mobile UI and UX involves issues including data privacy concerns, algorithmic bias. Besides that, it can be too much dependence on automated design recommendations to be tackle. This problematic that we must be solved to ensure ethical and user-centric AI implementation. The Design Development Research (DDR) is a systematic approach to creating mobile apps in educational settings, focusing on iterative design and user feedback. It involves collaboration between designers, developers, and end users to create engaging and user-friendly apps. The DDR framework incorporates

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EISSN: 0128-1666
Volume 11 Issue 42 (March 2026) PP. 78-92
elements of instructional design to ensure the app meets learning objectives. Combining DDR with the Design for Teaching (DT) framework can lead to more user-friendly and engaging applications. This method accelerates the development process and is suitable for diverse learning situations, both offline and online. The DDR-employed DT approach improves user experience and functionality, leading to increased satisfaction and engagement.

Emerging and adapting best practices of AI technology in educational systems and design presents numerous future opportunities for exploration. The integration of AI in developing UI prototype design within mobile learning apps is crucial for fostering innovative interactions and enriching lifelong learning experiences in education, as it is readily transferable and accessible anytime, anywhere (Kiranjeet Kaur, 2021). AI can serve as a resource for assisting learners and designers in creating UI and UX mobile app prototype designs that are visually appealing, user-friendly, and engaging for users (Xing et al. 2022). The advantages of AI in UI prototype design should be viewed as a new adaptation in the packaging design process that can enhance the quality of teaching and learning both in the classroom and independently for learners and educators (Seo et al. 2021). Nowadays, mobile learning apps generate new concepts and content, fostering engagement in learning within communities. The significance of this study is its potential to make a substantial impact on user interface and experience opportunities for educators and students in higher education, as well as for manufacturers and consumers. Figure 1 represents the integration of AI in DDR-employed DT in developing UI and UX mobile app in packaging design module as a solution to packaging design from traditional to digital. It shows this framework proven to be a model that's can effectively in improved the engagement and learning of packaging design. iDPAC gives the mobile apps learning more interactive and personalised experiences for users. This innovation approach has a potential to revolutionize the way of educators deliver the content. The students can be more engaged into the material that leading to a more efficient and the understanding of learning process will be increasingly. Besides, iDPAC also allow the real-time feedback and submission of the progression and artwork development. This creating a more tailored learning with the references in AI engaging experience for each individual user. This integration of AI in packaging design can lead to increased efficiency, cost saving, time saving with fasten result visually with improved the user satisfaction. Moreover, the industry designer can use iDPAC that can also lead to more sustainable practices by optimizing materials and reducing waste. This way can make a win-win for both businesses and the environment towards the Sustainable Development Goals (SDG 12 – Responsible Consumption and Production). iDPAC approaches aligned with the creative and innovative packaging solution that were developed to fill up the gap between consumer demand for sustainable packaging and industry capabilities. At the same time, integrating iDPAC into packaging design can help business stay competitively in the rapid changing market. This iDPAC can contributing to a more sustainable future.

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EISSN: 0128-1666
Volume 11 Issue 42 (March 2026) PP. 78-92

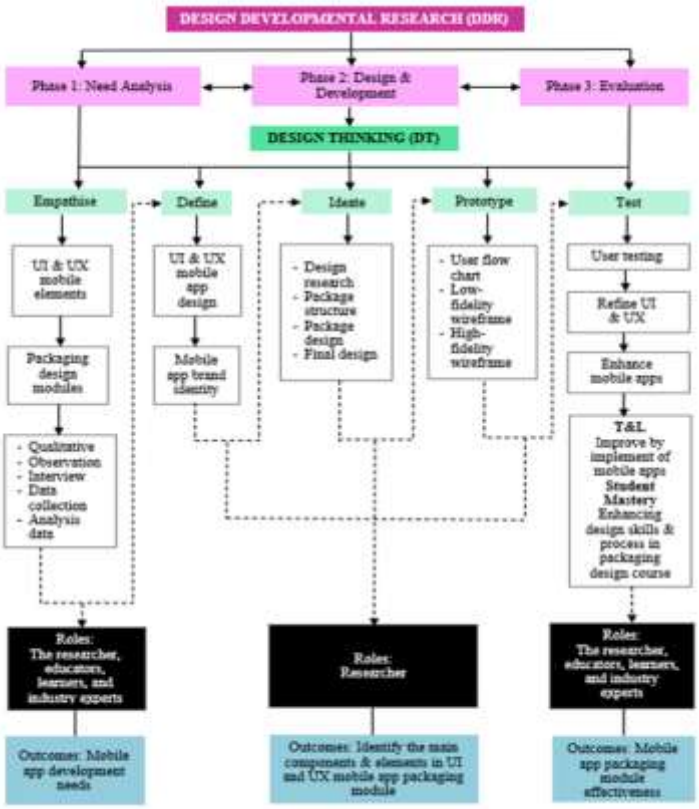

Figure 1: Adaptation Conceptual Framework in DDR combined DT Approaches from Padzil Mohd Ridzuan, Aidah Abdul Karim and Hazrati Husnin (2021).

Literature Review

In terms of UI and UX for mobile apps, key characteristics that facilitate this include drag-and-drop interfaces, device-specific templates, interactive gestures, real-time collaboration, and the ability to simulate application interactions (Clark, 2024). Moreover, Myre and Stevens (2023) stated that the various potential AI components and their interconnected relationships, such as machine learning algorithms, natural language processing, and computer vision, can work together to enhance the UI and UX design process. Therefore, UI and UX design elements also refer to the systematic approach designers use to create visually appealing and aesthetically pleasing interfaces in software or digital devices (S. Astuti et al. 2021). In addition, to emphasise the mobile app packaging design module, a product can be positively portrayed and attract attention with visually appealing elements such as typography, colour, and imagery (Rosene, 2022). According to Chitturi et al. (2021), Fishes (2019), and Li (2019), this visual element consists of colour, graphics, the size and shape of the packaging, and the pattern composition. Ultimately, Srivastava et al. (2022) indicated that the visual elements aspect can be categorised into two categories: verbal aspects (product details, brand name, manufacturer, and country of origin) and visual elements (colour, graphics, size and form, and typography). The DDR methodology is utilised for its flexibility and adaptability, enabling modifications during the development process (Rahman et al., 2024). DDR participants implemented DT, and emphasising the skills and knowledge involved in the design process will better equip students to tackle today's challenges (Padzil et al. 2021).

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Research Methodology

This research employs a qualitative methodology that proposes a design model to address the challenge of creating packaging modules in UI and UX mobile applications. This methodology involved the interview with nine-person semi-structured interviews with educators, learners, and industry experts to gather insights on potential improvements in AI integration in UI and UX mobile apps. This session with thoroughly directly interaction and observation of iDPAC among user around February. This research location is in Johor and Selangor. This method involves the NVIVO tools for data analysis to identify common themes and patterns in the interview's responses. Figure 2 explained the process of data collection and analysis using NVIVO tools shows the systematic approach taken in the research methodology. Moreover, this tool allows for a more efficient and organized of qualitative data. It's ensuring that key insight will be managed during the research process. The research also identified key areas for improvement from the interviews highlighted the importance of user-centred design principles in enhancing AI integration in mobile apps.

Figure 2: The Process of Data Collection and Analysis in Research Methodology Development iDPAC.

The model outlines steps for data collection and analysis, including ethical considerations. AI is recognised as a potential tool for developing prototypes, with the design process and packaging design module factors treated as independent variables. The DDR-employed DT framework has proven effective in guiding the design process and ensuring that ethical considerations are prioritized. Furthermore, the research suggests that incorporating AI into the design process can result in more efficient and innovative solutions for packaging modules in mobile applications. Figure 3 shows the details of research conceptual frameworks and how they can be integrated for optimal app development outcomes. By utilising both DDR and DT frameworks, developers can create apps that meet the learning objectives but also provide a seamless and enjoyable user experience. This approach is essential for ensuring that apps are effective tools for education and training in various settings.

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EISSN: 0128-1666
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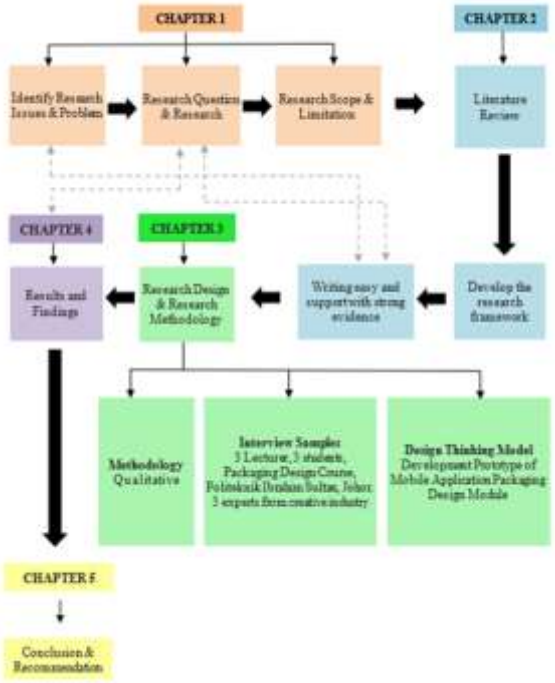

Figure 3: Research Design in Developing UI and UX Prototype Mobile App Packaging Design Module.

Results and Discussion

The five phases in DDR-employed DT framework shows results are empathised, define, ideate, prototype, and test. Table 1 represent these stages facilitate the design process by emphasising the comprehension of user requirements, delineating issues, developing concepts, formulating solutions, and evaluating their efficacy. By following these procedures, designers may guarantee that the finished product aligns with user expectations and operates well. This systematic method facilitates a comprehensive comprehension of customer requirements and ensures the product is customised to satisfy their expectations appropriately. The iterative nature of the approach enables continuous improvement based on user feedback, resulting in a more user-friendly and efficient finished product.

Table 1: DDR Employed DT Framework in Development of iDPAC Mobile Apps.

DDR	Phase 1: Need Analysis		Phase 2: Design and Development		Phase 3: Evaluation
DT	Empathize	Define	Ideate	Prototype	Test

DDR Phase 1: Needs Analysis – DT Stage 1: Empathize

In this stage, nine individuals, including lecturers, students, and creative experts in the UI, UX, and design industry, were interviewed. The demographics included females and males. The lecturers, aged 30-40, have a mix of education and experience. The students, aged 20-25, are studying graphic design. The experts, aged 25-40, have experience in software engineering and graphic design. Artificial intelligence (AI) is being used in education to educate students on current developments, promote understanding of creative technology, and improve

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EISSN: 0128-1666
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engagement and learning results. Generation Z is using AI to speed instruction, accelerate learning, and bridge the gap between traditional teaching methods and the digital age. AI tools like ChatGPT, Adobe Firefly, Midjourney, Ideogram, Suno, and Runway revolutionize student interaction with educational content, providing personalized feedback and support. This integration caters to individual learning styles and abilities, leading to more effective learning outcomes. The creative industry is also adapting to AI tools, enhancing creativity and collaboration. Therefore, this framework serves as a tool that educators utilise to integrate AI technology into educational practices, enhancing teaching strategies and preparing students for the future workforce. It manages the design process by identifying opportunities for AI integration and guiding designers in creating engaging content for their target demographic. By adapting to this framework, educators can intentionally implement AI technologies, benefiting both teachers and students, and ensuring that AI integration is meaningful and purposeful, leading to improved student learning outcomes. Furthermore, recognising this, packaging design is vital for visual communication and brand identity, as it represents the first point of contact with consumers. Imagery conveys emotions, connects with consumers, and distinguishes products. Moreover, typography enhances brand identity, clarity, and visual appeal, setting the tone and aiding customers in understanding product information.

DDR Phase 1: Needs Analysis – DT Stage 2: Define

The researcher identifies a specific problem based on user needs and insights from interviews. These insights are then analysed to target the issue, which could relate to packaging design. Potential solutions are brainstormed and evaluated for feasibility and effectiveness. The packaging design process involves creating recommendations and solutions. The design process for packaging design consists of creating recommendations and problem solutions as stated below:

1) A User Login for The Mobile Packaging Design Module.
2) A Design Process for The Mobile Packaging Design Module
3) A Verify Me Section Page
4) A Contact Me Section Page
5) A User Profile Section Page
6) Brand Identity of Mobile Packaging Design Module (Logo, rational and typography of iDPAC app)

DDR Phase 2: Design and Development – Stage 3: Ideate

In this stage, the ideas involved that will be utilised in the mobile application are organised and managed to identify solutions for the problems recognised in the second stage. Upon completing the solution ideas, they will be categorised according to essential criteria such as feasibility, cost-effectiveness, and user impact. This process ensures that the final product addresses the needs and expectations of the target audience while being practical and efficient. As illustrated in Figure 4, the researcher ranked the ideas and supervised the four categories of the design process for the mobile packaging design module. Firstly, design research encompasses eight categories: design brief, SWOT analysis, target audience, concept and idea, image application, visual package reference, die line references, mood board, package structure (die line diagram), package design (label design), and final package (packaging design mock-ups). Finally, the researcher conducted user testing and collected feedback to implement any necessary adjustments before finalising the mobile packaging design. This iterative process

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allows for continuous improvement and ensures a high-quality product that resonates with the end user.

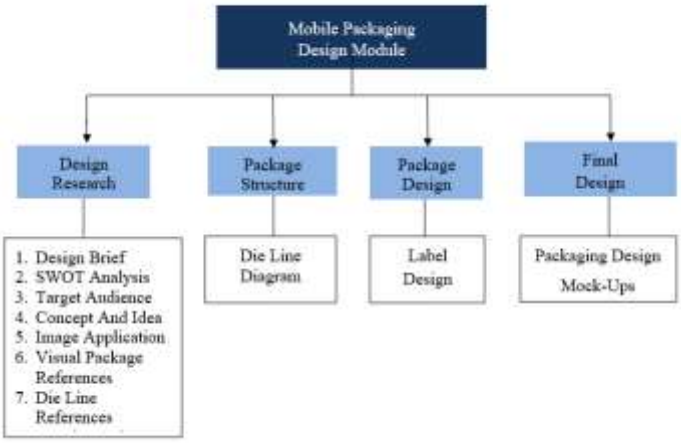

Figure 4: Categories of Design Process in iDPAC app.

Application Style of iDPAC App

The UI and UX design are contained in the application style. It involves essential designs such as the colour scheme, font, buttons, and text style defaults for the iDPAC application. This will help create a cohesive and visually appealing user interface that enhances the overall user experience. Additionally, focusing on accessibility features and responsive design will ensure that the iDPAC applications are user-friendly across different devices and platforms. The UI and UX design enhance the user experience and ensure easy navigation within the iDPAC application. It needs to be visually appealing, user-friendly, and consistent with the overall brand image of the iDPAC application. The results are shown in Figure 4 in the detailed description.

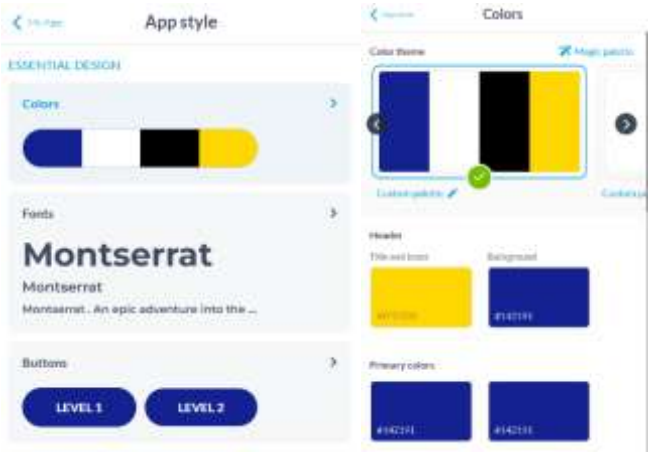

Figure 4: Application Style Default For iDPAC Application Structure Design Style.

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DDR Phase 2: Design and Development - Stage 4: Prototype

The prototype plays a vital role in user flow design, allowing for hands-on testing and assessment of packaging design prior to the final development of the application. It offers a tangible representation of the final application, supporting decision-making and the refinement of user interface design elements. Testing with actual users helps pinpoint areas for improvement. The user flow is illustrated in Figure 5, depicting a sequential series of steps that a user will follow when interacting with the mobile application.

Figure 5: User Flow in iDPAC App.

Wireframe

Wireframing in mobile application development is an essential step that allows developers to visualize the layout and functionality of the app before coding begins. It helps ensure that the user interface design meets the needs and expectations of users, ultimately leading to a more successful application launch. This wireframe is divided into two categories: low-fidelity wireframes, which focus on basic layout and structure, and high-fidelity wireframes, which include more detailed design elements such as colour, fonts, and images. These wireframes serve as a blueprint for the final design of the iDPAC application, guiding developers in creating a cohesive and user-friendly interface.

Low-fidelity Wireframe

The low-fidelity UI and UX mobile app design, developed using Figma, allows users to customize their own packaging designs and receive feedback from industry professionals. The app includes tutorials and resources to help users understand packaging design principles. Figure 6 shows the section page for each section inside the iDPAC application. The wireframe design allows for quick visualization of the module's layout before high-fidelity prototypes are created.

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Figure 6: UI and UX Design for iDPAC App in Low Fidelity Development.

High-fidelity Wireframe

After developing the low-fidelity UI and UX mobile app design, the researcher crafted the final design with various graphical elements, including icons, layouts, grids, colours, sans-serif typography, and button navigation. This process ensures that the final product is user-friendly and visually appealing. By incorporating these design elements, the researcher creates a seamless and intuitive experience for users interacting with the iDPAC application. The high-fidelity design provides a more realistic representation of the final product, making it easier to identify any potential issues prior to development. Furthermore, user testing can be conducted on the high-fidelity prototype to gather valuable feedback for further enhancements. Figure 7 illustrates the next stage in the design process, showcasing the detailed visual elements incorporated into the final product. This stage permits a more realistic depiction of the user interface and overall user experience. By employing high-fidelity UI and UX mobile app prototypes, designers can obtain more accurate feedback from users and stakeholders, resulting in a more refined final product. This stage also facilitates the fine-tuning of UI and UX mobile app design elements before proceeding to development, thereby saving time and resources in the long run.

Figure 7: UI and UX Design iDPAC Display of The High-Fidelity Prototype in Figma.com.

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Source: https://www.figma.com/proto/vl5NBpG9hOuYFp7ZuLVKKt/iDPac-04_USER-TESTING?node-id=2057-134&node-type=canvas&t=aHYuyKy9awzUkibu-1&scaling=scale-down&content-scaling=fixed&page-id=0%3A1.

DDR Phase 3: Evaluation – DT Stage 5: Test

User testing for iDPAC has concluded, ensuring the final product meets consumer expectations and identifies potential usability issues. A final prototype has been developed, which will undergo a final round of testing to address any issues before launch. Feedback from this testing phase will be crucial in final adjustments to the iDPAC application, ensuring the best user experience. The application is divided into four main sections: main section page, packaging design process, user profile authentication, and packaging design submission. Each section aims to provide a seamless user experience and intuitive navigation, aiming to simplify the packaging design process for all users. Figure 8 shows the final iDPAC app interface, highlighting the clean design and user-friendly layout. The development team is confident that the app will meet the needs of users and provide a valuable tool for packaging design.

Figure 8: iDPAC App AI-powered for Packaging Design Solution.

Conclusion

Therefore, the iDPAC application has been registered in Google Console as a published application on the Play Store for Android users. Meanwhile, Apple users can download the iDPAC app in the App Store for the iOS platform (Figure 9). This ensures that the app is easily accessible to a wide range of users, regardless of their device preferences. Moreover, iDPAC mobile applications have been registered with the Intellectual Property Corporation of Malaysia (myIPO) for copyright in notification number; CRAR2025J00267, and all contents are reserved for consent. Additionally, regularly updating the application and addressing user concerns will help maintain a positive reputation and keep users engaged. Protecting the intellectual property rights of the iDPAC application ensures that all content remains secure and exclusive to the developers. This innovative use of technology enhances the learning experience and equips students with valuable skills that are in high demand in the rapidly evolving field of packaging design, independently outside the classroom, as a supporting tool for continuous learning and professional development. The iDPAC mobile application also provides real-time feedback and personalised recommendations based on individual progress, further optimising the educational experience for students. The iDPAC mobile app provides a valuable platform for learners to explore design possibilities, understand visual constraints, and

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refine their designs based on AI-powered feedback and suggestions. This interactive platform allows students to enhance their critical thinking and problem-solving abilities, ultimately preparing them for success in the competitive job market. This approach will also foster a culture of innovation and creativity within the industry, driving further advancements in AI integration. Overall, incorporating a dynamic and industry-focused curriculum will better equip students to navigate the rapidly evolving field of packaging design and stay ahead of the curve. This proactive approach will ensure that graduates are well-prepared to meet the demands of an ever-changing market and contribute to the continued growth and development of the industry.

Figure 9: iDPAC App in Google Play and App Store.

Moreover, the study emphasized the need for ongoing user feedback and testing to ensure that AI technology in iDPAC mobile apps is relevant to meet the user needs and expectations. By focusing on these areas, developers can continue to be driven innovation with the improvements the functionality of integration AI in mobile applications. Overall, iDPAC served as a strategic enabler that bridges academic researcher, industrial applications and national SDG and EDG initiatives in Malaysia with the goal of fostering sustainable development and increasing economic growth. Through collaboration and knowledge sharing, iDPAC aims to create more inclusive and technologically advanced society that benefits all users involved. By leveraging AI technology into mobile apps, iDPAC can further enhance its impactful and contribute to the advancement of Malaysia digital economy and education.

Acknowledgements: The author would like to express my sincere gratitude to Politeknik Ibrahim Sultan, for the valuable guidance and support throughout the course of this research. Special thanks are also extended to colleagues for their assistance and contributions. The feedback technical assistance and insightful discussion give the significantly enriched the quality of this research. Finally, thanks are given to all individual who directly contributed to realization of this research.

Funding Statement: No Funding

Conflict of Interest Statement: The author declares that there is no conflict of interest regarding the publication of this paper. The author has contributed to this work and approved the final version of the manuscript for submission to the Journal of Information System and Technology Management (JISTM)

Ethics Statement: This study was conducted in accordance with ethical research standards. All procedures involving human participants were reviewed and approved by the 8th IRCMST 2025: 077-054. Informed consent was obtained from all participants prior to data collection. Participation was voluntary, and respondents were assured of confidentiality and anonymity. The data collected were used solely for academic purposes.

Author Contribution Statement: The author contributed significantly to the development of this manuscript. The author was responsible for the conceptualization, methodology, and overall supervision of the study including handled data collection, analysis, and interpretation of results. Besides, the author contributed to the literature review, drafting, and critical revision of the manuscript. The author read and approved the final version of the manuscript prior to submission.

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