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Development of an Artificial Intelligence-Assisted E-Certificate System at Melaka Polytechnic

(An Innovative Approach to TVET Digital Transformation)

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Abstract

Introduction/Main Objectives: This study discusses the development of an AI-assisted e-Certificate system at Melaka Polytechnic to address issues related to manual certificate preparation.

Background Problems: The manual certificate preparation process involves long processing times, high risks of human error, and significant operational costs.

Novelty: The novelty lies in the collaborative human-AI development approach, where ChatGPT was utilized as an assistant to generate the programming code, enabling system development by non-programming staff within an educational institution.

Research Methods: The system development methodology employed a collaborative human-AI approach. ChatGPT was used as a development assistant to generate programming code in PHP, HTML, CSS, JavaScript, and MySQL.

Finding/Results: The e-Certificate system was successfully developed with features including full automation, responsive design, and efficient data management. The system reduced development costs by 85.7% compared to conventional methods. It decreased certificate processing time by 82%. User satisfaction scored 4.5 out of 5.0.

Conclusion: This study successfully demonstrates the significant potential of AI-assisted tools in information system development, particularly for enabling non-programming staff in educational institutions to create efficient, cost-effective digital solutions.

Keywords: e-Certificate, artificial intelligence, automation, software development, digital transformation

Introduction

Digital transformation in education has become a crucial necessity in the era of the Industrial Revolution 4.0 (Chen & Kumar, 2023). The rapid development of information and communication technology has changed the global education landscape, with educational institutions worldwide shifting to digital solutions to enhance operational efficiency. In Malaysia, government initiatives such as MyDIGITAL and the Malaysia Digital Economy Blueprint have accelerated the digital transformation process in the education sector (Ministry of Education Malaysia, 2022). The national digital education policy emphasizes the importance of using technology to improve the quality of educational management.

The certificate management process in technical and vocational education and training (TVET) institutions like Melaka Polytechnic still relies on time-consuming and resource-intensive manual methods (Smith et al., 2021). As shown in Table 1, the manual process for certificate preparation requires an average of five to seven working days to complete after a course ends, compared to only 7.5 to 13 minutes with the AI-assisted e-Certificate system. This delay not only affects customer satisfaction but also increases the institution's operational costs. This problem becomes more critical in the context of TVET education where short courses are frequently held and require rapid certificate issuance.

The emergence of generative artificial intelligence and large language models like ChatGPT has opened new dimensions in software development (Hou et al., 2024). This technology enables individuals without deep programming backgrounds to develop functional systems through an AI-assisted development approach. Recent studies show that AI-based development assistants can increase developer productivity by up to 55.8% compared to conventional methods (Peng et al., 2023). However, the practical application of this technology in the context of Malaysian educational institutions is still understudied (Abdullah & Hassan, 2023).

A significant research gap exists in understanding how AI-assisted development approaches can be effectively implemented in local educational institutions, particularly in the TVET context. Most existing studies focus on AI applications in pedagogical aspects, while applications in educational administrative management are still underexplored. This study aims to fill this gap by developing an e-Certificate system using an AI-assisted development approach.

Table 1 Comparative Analysis of Certificate Management Systems

Aspect	Manual System	Conventional Digital System	AI-Assisted E-Certificate System
Processing Time	5-7 days	1-2 days	7.5-13 minutes
Development Cost	None	RM20,000-RM30,000	RM4,300
Staff Requirement	3-4 people	1-2 people	1 person
Error Risk	High	Medium	Low
Verification Capability	Manual	Limited Digital	Full Digital
System Integration	None	Limited	Comprehensive

Source: Comparative Analysis, 2025

This study has four main objectives: first, to analyze the needs of a digital certificate management system at Melaka Polytechnic; second, to design and develop an e-Certificate system using an AI-assisted development approach; third, to evaluate the system's performance from technical and user satisfaction aspects; and fourth, to analyze the impact of AI-assisted development on cost and time efficiency.

The significance of this study lies in its potential to provide a replicable model for other educational institutions facing similar challenges. The findings are expected to contribute to the body of knowledge on AI applications in educational management and provide practical guidance for implementing digital transformation in educational institutions.

Research Methods

This study uses the Design and Development Research (DDR) approach according to the framework proposed by Richey and Klein (2014). This approach was chosen for its suitability in developing practical solutions to educational problems while contributing to theoretical knowledge. The research methodology consists of three main phases implemented in series: the needs analysis phase, the system design and development phase, and the testing and evaluation phase.

The needs analysis phase was conducted over four weeks and involved data collection from various sources. Six staff members from the Unit of Training and Continuing Education (ULPL) and the Information Technology Unit at Melaka Polytechnic were purposively selected to participate in structured interviews. As shown in Table 2, participants consisted of various roles with work experience ranging from 3 to 15 years, ensuring comprehensive coverage of perspectives. Participant selection was based on their direct experience in handling the certificate management process. Interviews were conducted using a standardized interview protocol covering questions about current challenges, functional needs, and improvement suggestions.

Table 2 Respondent Profile for Needs Analysis Phase

Category	Number	Role	Experience (years)
Manager	1	Process Supervision	15
Senior Staff	1	Main Execution	10
Junior Staff	1	Operational Support	8
Technical	3	IT Support	3-10
Total	**6**	**-**	**-**

Source: Primary Data, 2025

In addition to interviews, document analysis was conducted on existing standard operating procedures (SOPs) for certificate management workflows. A comparative study was also performed on five commercial e-Certificate systems available on the market to identify key features and shortcomings that needed to be addressed. Analysis of all this qualitative data was performed using thematic analysis methods to identify patterns and main themes.

Based on the needs analysis, a list of functional and non-functional system requirements was established. As summarized in Table 3, functional requirements include full automation of the certificate generation process, PDF export capability, responsive interface design, robust data security mechanisms, and integration capability with existing systems. Non-functional

requirements include high performance with response times of less than three seconds, 99% system availability, and scalability to accommodate future user growth.

Table 3 System Functional Requirements Analysis

No.	Requirement	Priority	Description	Status
1	Certificate Automation	High	Automatic certificate generation after participant verification	Included
2	PDF Export	High	Professional format for download	Included
3	Responsive Design	Medium	Compatibility with all devices	Included
4	Data Security	High	User data protection	Included
5	Database Integration	High	Connection with existing systems	Included
6	Statistical Reports	Medium	System usage analysis	Included
7	Digital Verification	High	Digital certificate verification	Included

Source: Needs Analysis, 2025

The system design and development phase took eight weeks to complete. The system architecture was designed based on a three-layer model: presentation layer, application layer, and data layer. The presentation layer was developed using HTML5, CSS3, and JavaScript with the Bootstrap framework to ensure responsive design. The application layer used PHP 8.0 with Adobe Dreamweaver for code writing. The data layer used the MySQL 8.0 database management system with appropriate data normalization.

ChatGPT was integrated as an AI co-developer throughout the development phase (Brown & Wilson, 2023). The development process followed an iterative approach where ChatGPT was used to generate initial code based on detailed specifications, followed by a review and refinement process by human developers. As shown in Table 4, various technologies and tools were used in the development process, including HTML5, CSS3, JavaScript, Bootstrap, PHP 8.0, Adobe Dreamweaver, MySQL 8.0, and ChatGPT 4.0. This collaborative approach enabled this combination to have programming expertise to develop a fully functional system.

Table 4 Development Technologies and Tools

Category	Technology	Version	Use
Frontend	HTML5	-	Page Structure
	CSS3	-	Styling and Layout
	JavaScript	ES6	Interactivity
	Bootstrap	5.0	Responsive Framework
Backend	PHP	8.0	Application Logic
Database	MySQL	8.0	Database
AI Tools	ChatGPT	4.0	Development Assistance
Server	Apache	2.4	Web Server
	Linux	Ubuntu 20.04	Operating System

Source: Technical Documentation, 2025

The testing and evaluation phase involved three types of testing: usability testing, technical performance testing, and user acceptance testing. Usability testing was conducted with thirty end-users consisting of administrative staff and course participants. Instrumentation included questionnaires using a five-point Likert scale and structured observation protocols.

Technical performance testing assessed metrics including system response time, memory usage, stability under high load, and compatibility with different web browsers. Load testing was conducted using the Apache JMeter tool to simulate up to 100 concurrent users. Security testing included basic penetration tests and code audits to identify potential vulnerabilities.

Quantitative data analysis used descriptive and inferential statistics. Paired t-tests were used to compare processing times before and after system implementation. Reliability analysis using Cronbach's Alpha coefficient was performed to assess the internal consistency of the measurement instruments. Qualitative data were analyzed using content analysis to identify themes and patterns in user feedback.

Result

The system development results showed the successful production of a fully functional e-Certificate system with all planned features. The system demonstrated robust performance in automatic certificate generation, unique serial number assignment and data verification. Technical tests found the system capable of maintaining optimal performance even under high load.

A detailed analysis of the system performance metrics showed encouraging results. As shown in Table 5, the average time to generate a single certificate was 2.8 seconds with a standard deviation of 0.3 seconds, exceeding the set target of less than 5 seconds. The system maintained 99.2% uptime during the thirty-day testing period without any data loss incidents. The user error rate was recorded at 8%, mostly originating from basic data input errors.

Table 5 System Performance Metrics

No.	Performance Indicator	Result	Target	Status
1	Single Certificate Gen. Time	2.8 seconds	<5 seconds	Excellent
2	System Uptime (30 days)	99.2%	>95%	Excellent
3	Data Loss Incidents	0	0	Excellent
4	User Error Rate	8%	<10%	Good
5	Average Response Time	1.2 seconds	<3 seconds	Excellent
6	Maximum CPU Usage	65%	<80%	Good
7	Maximum Memory Usage	450MB	<512MB	Good

Source: System Performance Data, 2025

The cost efficiency study showed significant savings compared to conventional methods (Johnson et al., 2023). As summarized in Table 6, the initial investment for system development using AI assistance amounted to RM4,300, representing an 85.7% saving compared to the estimated conventional development cost of RM30,000. A detailed analysis of cost components showed reductions in all aspects including developer costs, software costs, training costs, and maintenance costs.

Table 6 Cost Comparison Analysis

No.	Cost Component	Conventional Method	AI-Assisted	Savings
1	Developer Cost	RM15,000	RM2,000	RM13,000
2	Software Cost	RM5,000	RM500	RM4,500

No.	Cost Component	Conventional Method	AI-Assisted	Savings
3	Training Cost	RM3,000	RM300	RM2,700
4	Maintenance Cost	RM7,000	RM1,500	RM5,500
	Total	**RM30,000**	**RM4,300**	**RM25,700**

Source: Cost Analysis, 2025

In terms of time efficiency, the system achieved an 82% reduction in certificate processing time. The manual process, which previously took between 70 to 92 minutes per certificate, was successfully reduced to only 7.5 to 13 minutes through comprehensive automation. The cumulative time savings amounted to 1,336 minutes (22.3 hours) per month based on an average of twenty certificates processed, equivalent to 2.8 working days.

The user satisfaction assessment involving thirty participants showed an average score of 4.5 out of 5.0 (Lee et al., 2022). As shown in Table 7, a detailed analysis of satisfaction aspects showed the highest scores for ease of use (4.6/5.0) and interface design (4.5/5.0), followed by system speed (4.4/5.0) and system reliability (4.3/5.0). The System Usability Scale (SUS) score of 82.5 placed the system in the excellent usability category.

Table 7 User Satisfaction Results

Assessment Aspect	Score (5.0)	Std. Deviation	Level
Ease of Use	4.6	0.3	Very Good
System Speed	4.4	0.4	Good
Interface Design	4.5	0.2	Very Good
System Reliability	4.3	0.5	Good
Output Quality	4.4	0.3	Good
Technical Support	4.2	0.6	Good
Overall Average	**4.5**	**0.4**	**Very Good**

Source: User Satisfaction Survey, 2025

Advanced technical testing revealed that the system maintained stable performance even under high load of up to 100 concurrent users. The average response time remained below three seconds in all test scenarios. Security testing confirmed the absence of critical vulnerabilities in the system, with all sensitive data stored in encrypted form.

Analysis of qualitative data from post-testing interviews revealed several main themes. Users reported significant improvements in work efficiency and reduced stress related to certificate management tasks. They also expressed satisfaction with the intuitive and easy-to-use interface even without extensive formal training.

Discussion

The achievement of developing the e-Certificate system through an AI-assisted approach contributes to a deeper understanding of the transformative potential of AI in educational software development (Zhang & Li, 2024). The findings of this study align with current trends in the literature showing increased interest in AI applications in education, but this study expands the scope of application to the domain of administrative management.

As compared in Table 8, the 85.7% cost saving achieved in this study exceeds the industry average reported in previous studies. Johnson et al. (2023) reported 70% cost savings for automation projects in educational administration, while Brown & Wilson (2023) recorded 75% for AI applications in software development. The superior performance in this study can be attributed to the innovative approach of integrating ChatGPT as a development partner, which reduced reliance on specific technical expertise.

Table 8 Comparison with Previous Studies

Study	Context	Method	Cost Saving	Productivity Increase
This Study	Malaysian TVET	DDR with AI	85.7%	82%
Johnson et al. (2023)	Higher Education	Automation	70%	65%
Peng et al. (2023)	Software Development	AI Assistance	-	55.8%
Lee et al. (2022)	Digital Transformation	Case Study	60%	70%
Brown & Wilson (2023)	AI in Development	Experiment	75%	60%

Source Comparative Analysis, 2025

The findings on time efficiency showing an 82% reduction in certificate processing time are consistent with the findings of Peng et al. (2023) who reported a 55.8% productivity increase for developers using AI assistance. The difference in the percentage increase can be explained by context-specific factors including the type of task and the level of automation achieved.

The high user satisfaction with an SUS score of 82.5 reinforces the findings of Lee et al. (2022) on the importance of user-centered design in educational systems. The score achieved exceeds the industry average of 68 reported in the literature for educational information systems, demonstrating the effectiveness of the design approach used.

The successful implementation of the system in the Malaysian TVET context supports the view of Wong and Tan (2024) on the suitability of AI-assisted development approaches for vocational education institutions. These findings are consistent with the Malaysian digital education policy that encourages the use of innovative technologies in educational transformation (Ministry of Science, Technology and Innovation, 2023).

However, this study also identified several important limitations. The relatively short evaluation period may not capture the long-term effects of the system. The moderate sample size limits the generalizability of the findings, and reliance on a specific AI platform may affect the reusability of the solution in different contexts.

Main challenges faced included issues of integration with existing legacy systems and the need for continuous staff training. The experience of this study shows that even with AI assistance, digital transformation still requires organizational change and adaptation of work culture.

Practical implications of this study include providing a model that can be adapted by other educational institutions, especially those with limited resources. The AI-assisted development approach offers a cost-effective pathway for institutions wishing to implement digital transformation without large investments in technology infrastructure.

Conclusion

This study has successfully proven the effectiveness of the AI-assisted development approach in producing a fully functional e-Certificate system for Melaka Polytechnic. Key achievements include development cost savings of 85.7%, an 82% reduction in certificate processing time, and a high user satisfaction level of 4.5/5.0. All study objectives have been achieved, proving that AI-assisted development is a viable strategy for digital transformation in educational institutions.

The study findings make an important contribution to the existing knowledge on AI applications in education (Chen & Kumar, 2023). The proposed development model offers a practical solution to the problem of manual certificate management while demonstrating the potential of AI to bridge technical skill gaps in educational institutions. This approach aligns with the nation's digital transformation aspirations and can be replicated by other institutions facing similar challenges.

Based on the study experience, several suggestions for future research are proposed. First, further studies are needed to assess the long-term impact of this approach on organizational efficiency. Second, research on the integration of additional technologies like blockchain for certificate verification could be considered. Third, comparative studies between various AI platforms in the context of educational system development would provide valuable insights.

This study also suggests several policy implications for educational institutions. Management should consider integrating AI-assisted development approaches into their digital transformation strategies. Training programs need to be adapted to enable staff to fully leverage the potential of this technology. Cooperation between educational institutions could be strengthened to share knowledge and resources in system development.

Despite facing several limitations, this study has provided a solid foundation for further exploration of AI applications in educational management. The potential of this approach to revolutionize how educational institutions develop information systems is significant, especially in resource-limited contexts. Continued research in this area is expected to contribute to increased efficiency and effectiveness of educational management in Malaysia.

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