Online-Journals.org

iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 18 No. 22 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijim.v18i22.49227

PAPER

Enhancing the Efficiency of Internship Management through the Implementation of Progressive Web App

Wisut Petcharat, Taechita Sutthirak(✉)

Faculty of Management Science, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat, Thailand

taechita_sut@nstru.ac.th

ABSTRACT

This study aims to 1) develop and evaluate Progressive Web App (PWA) for student internship management, 2) assess the effectiveness of these PWA, and 3) evaluate user satisfaction with the PWA. The research sample consists of 102 students and teachers selected through purposive sampling, along with five experts in system development. Data collection tools used in this study include a system performance evaluation questionnaire and a user satisfaction questionnaire. Data analysis was conducted using mean and standard deviation. The results indicate that the PWA for Student Internship Management, developed using the ADDIE Model, supports cross-platform functionality and can be used immediately without installation. The system efficiently streamlines the management of student internships, reducing workflow steps, and allowing teachers to manage student internship data and evaluate performance effectively. Teachers can also provide continuous supervision and consultation throughout the internship period. According to the satisfaction evaluation, the PWA effectively meets user experience needs, with an average User Experience score of 4.85. The overall system performance is rated as very high with a score of 4.76, and user satisfaction is also rated very high with a score of 4.80.

KEYWORDS

Progressive Web App (PWA), ADDIE model, student internship, management system

1 INTRODUCTION

In Thailand, higher education mandates that professional experience training be an essential course for students [1]. Professional experience training for students before graduation is designed to provide real-world learning and working experiences in a professional setting. This training allows students to live and practice in actual workplaces, enhancing their direct work experience. It aims to give students a realistic understanding of workplace situations and conditions and to apply the theoretical and practical knowledge they have acquired. Professional experience training is considered a process that enhances skills and provides valuable experience for career development. Students can use advanced technological tools and equipment

Petcharat, W., Sutthirak, T. (2024). Enhancing the Efficiency of Internship Management through the Implementation of Progressive Web App. *International Journal of Interactive Mobile Technologies (iJIM)*, 18(22), pp. 19–34. https://doi.org/10.3991/ijim.v18i22.49227

Article submitted 2024-03-20. Revision uploaded 2024-09-14. Final acceptance 2024-09-16.

that are rapidly evolving in the business world, preparing them to become quality graduates who meet the needs of various organizations. In Thailand, professional experience training is included in the undergraduate curriculum standards, requiring both theoretical and practical coursework, such as internships or fieldwork [2].

The Bachelor of Business Administration program in Management at Nakhon Si Thammarat Rajabhat University requires students to undergo professional experience training as part of the curriculum structure. Every academic year, approximately 100 students participate in this training. These students are assigned to various enterprises, with more than 20 organizations located across the southern region and other provinces. The Department of Management within the Faculty of Management Science assigns faculty supervisors, known as internship advisors, to oversee and support the students. These advisors are responsible for providing guidance, monitoring progress, and coordinating with the enterprises throughout the training period. They address any challenges that arise and evaluate the student's performance during their professional experience training [3]. Currently, several challenges are commonly encountered. First, there are delays in the submission of training requests, often due to the reliance on paper documents. Second, communication with students and enterprises is problematic, especially as students travel to various provinces for their training. Contact information is often stored in files and documents, making coordination inefficient. Third, the reporting and absence management process presents challenges. Faculty supervisors must assess students during evaluations and send scores to the responsible faculty members for compilation. This process is prone to errors, and sometimes scores are not submitted on time, affecting students' grades and their ability to graduate. Fourth, faculty supervisors face delays in planning their travel routes to various training locations, such as hotels and companies spread across different provinces, leading to inefficiencies. Finally, there is a lack of information systems and applications to facilitate these tasks. The development of an application to support these processes would enable more efficient management of professional internships, streamline procedures, and reduce time, thus improving the overall effectiveness of managing students' professional internship experiences.

In the current era, information technology is increasingly being adopted to solve problems and facilitate work. This includes the development of information systems, web applications, and mobile applications. These technological solutions can effectively address the issues faced. Today, applications are widely used in both the government and business sectors, and mobile phones are commonly utilized for various activities. Data from 2022 shows that mobile phones are the most-used device for internet access at 97.07%, followed by tablets at 19.35%, notebooks at 18.42%, desktop computers at 17.80%, and other devices at 25.63% [4]. Among students, the use of mobile phones is as high as 98% [5]. Students can access learning and receive information anytime and anywhere without being limited by location or time. Additionally, it enables instructors to assign tasks, conduct quizzes, and evaluate performance through mobile phones [6].

There has been research related to the development of student internship management applications, though it has primarily focused on web application development. Few studies have concentrated on developing mobile applications. This study presents the development of a Progressive Web App (PWA), a new concept built on existing standard web technologies, including HTML, CSS, and JavaScript. PWAs use caching and web storage to provide users with an app-like experience without requiring downloads or installations. They can function offline, support push notifications, and enable background synchronization, similar to native applications [7]. Additionally, they can operate on desktop computers or other devices regardless of the operating system [8].

The ADDIE Model will be used to ensure efficient development of the system. This flexible model is well-suited for developing educational systems efficiently. The development process includes five steps: analysis, design, develop, implement, and evaluate. To address issues and enhance the management of professional experience training, the PWA allows faculty to conveniently manage and evaluate students' professional internships, while students can easily and quickly receive updates and report their internship progress through the PWA. Additionally, the efficiency of the PWA for student internship management will be evaluated.

2 LITERATURE REVIEW

The researcher has reviewed relevant studies that are significant to the development of a PWA for Student Internship Management. One notable study is "The Development of a Web-Based Computer Laboratory Management Information System at SMKS Pertiwi Batam" [9]. This system, developed using the waterfall model, is web-based and effectively addresses management, usage tracking, and scheduling of computer laboratory sessions. As a result, it offers increased flexibility. Another study, "Designing Learning Media Using Augmented Reality for the Engineering Mechanics Course" [10], found that the AR system developed through the SDLC process provides an alternative for distance learning. It allows students to access learning materials anytime and anywhere, extending their usage time. In another study, "Design and Implementation of a Web-Based Information System for Domestic Sea Transportation Services of Goods" [11], the system was developed using the waterfall model and unified modeling language (UML). The use of PHP programming and a MySQL database resulted in a web application that enabled PT NSE to manage operations in a timely and accurate manner, enhancing the efficiency of the executive dashboard. Furthermore, the study "Designing Instructional Media Integrated with Mobile Augmented Reality Technology" [12] employed the multimedia development life cycle (MDLC) model. The research demonstrated that AR-based instructional media, developed through a series of steps including design, material collection, and testing, could simulate objects in 3D, specifically for CNC lathe training.

The authors [13] involved the development of mobile augmented reality (AR) applications for engineering mechanics learning, featuring interactive 3D objects. Using the ASSURE instructional design model, the study found that AR-based learning media positively impacted students' understanding of fundamental concepts. Moreover, AR media supported self-directed learning and provided immediate feedback to students. Additionally, another study titled "The Development of Android-Based Computer and Basic Network Learning Media" [14] employed the ADDIE model, resulting in a system that effectively supports teachers and students and is practical for real-world use.

The reviewed studies show that both web and mobile applications have been developed to support various aspects of educational management. Notably, in the area of professional internships, the research by the authors [15] developed an online management information system for cooperative education and internships at Sisaket Rajabhat University. The system, developed using the SDLC process, was found to function effectively online, divided into user and admin sections, with high effectiveness ratings in evaluations. The study by the authors [16] also developed an information system for internships and establishment evaluations. This web application, composed of eight subsystems, managed internships effectively and received high ratings for its data input design, workflow, and output design.

Further studies: Most research focused on developing web-based professional internship management systems, effectively supporting staff, faculty, and students. There are only a few studies that enhanced these systems into mobile web applications with responsive display techniques using CSS frameworks. Although these systems were effective, limitations in terms of display quality and functionality were noted. Most systems did not fully support mobile phone functionality, and those that did still faced performance limitations.

The reviewed research highlights that web applications are commonly used for educational management but often lack mobile phone support. Responsive display techniques help improve functionality, though limitations remain. However, the studies also recommend developing systems that fully support mobile devices to enhance user convenience and speed. This development can increase costs to ensure compatibility. Currently, applications using PWA technology offer a solution, reducing development costs and complexity. PWAs, based on standard web technologies such as HTML, CSS, and JavaScript, provide an app-like experience without requiring downloads or installations. They can function offline, support push notifications, and synchronize in the background, much like native applications [7]. Furthermore, they can operate on desktop computers or other devices, regardless of the operating system, as shown in Figure 1 [8].

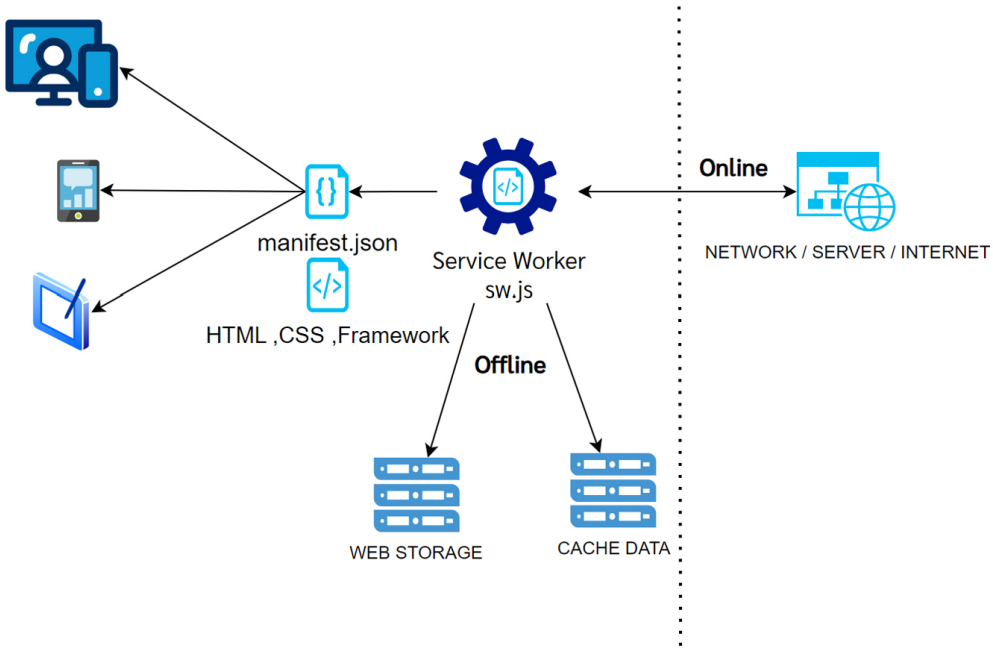

Fig. 1. Progressive web app (PWA)

The operation of a PWA begins when the first file is opened:

Service worker.js loading: The application loads the service worker.js file. This crucial file checks the connection and verifies the cache. If no data is found in the cache, it fetches the data from the server and saves it to the cache for future use by the application.

Manifest.json loading: The manifest.json file is loaded and sets the display configuration to ensure it is appropriate for the device [17] [18]. Key components of a PWA include the manifest.json file, which configures various settings, including display options and system icons, as shown in Figure 2. Additionally, the service worker.js file controls the operation of the PWA by processing data storage in the

cache or fetching data from the server according to the specified procedures, as illustrated in Figure 3.

```
{
 "name": "ระบบสารสนเทศนักศึกษาฝึกฯ",
 "short_name": "MsInternShips",
 "theme_color": "#fff",
 "background_color": "#fff",
 "display": "standalone",
 "orientation": "portrait",
 "scope": "/",
 "start_url": "./index.html",
 "icons": [
   {
     "src": "images/icons/icon-72x72.png",
     "sizes": "72x72",
     "type": "image/png"
   }
 ]
}
```

Fig. 2. Example manifest.js

```
self.addEventListener('install', function(e) {
 console.log('install');
 e.waitUntil(
   caches.open('studentIntern').then(cache => {
     return cache.addAll([
       './',
       './index.html',
       './images',
   './data',
       'https://unpkg.com/onsenui/css/onsenui.css',
       'https://unpkg.com/onsenui/css/onsenui.min.css',
       'https://unpkg.com/onsenui/css/onsen-css-components.min.css',
       'https://unpkg.com/onsenui/js/onsenui.min.js',
       'https://unpkg.com/jquery/dist/jquery.min.js'
     ]);
   })
 );
});

self.addEventListener('fetch', function(e) {
 e.respondWith(
   caches.match(e.request)
     .then(response => response || fetch(e.request))
 );
});
```

Fig. 3. Example service worker.js

The development of PWA is found in the research of the authors [19]. The research developed IoT using PWA. The results showed that the developed PWA is compatible with microservice architecture and can display spatial data as well as data from IoT devices. In the research [20], a comparison was made between the responsiveness of PWA and the Android operating system by evaluating the use of the camera and geolocation. The results showed that the camera functioned better and faster on Android than on PWA. However, PWA performed better in terms of geolocation. In [21], a study on the development of PWA examined its popularity by analyzing research conducted between 2015 and 2021, it was found that 73% of the studies focused on the practice of PWA, and there is annual growth in the practice of PWA. Additionally, the study explored energy consumption. In the research of the author [8], a comparative study on the energy consumption of PWA was conducted. The results showed that, compared to native apps, PWA consumes slightly

more energy. However, PWA is still a good option for cross-platform development. The research also indicated that web browsers have a direct impact on the testing outcomes. Improvements in web browsers in the future could enhance the performance of Progressive Web App.

Based on the study of research and the provided data, the development of PWA has enhanced its ability to be used across various devices and to operate quickly, providing a user experience similar to that of traditional applications without the need for installation. PWA supports the management of students during internships, facilitates travel for supervision, and enables efficient evaluation after supervision. This technology will make the student internship information system more comprehensive and effective, ensuring students are well-supported throughout their professional experience and training. In this study, the ADDIE method was chosen as it is well-suited for educational systems, encompassing the processes of analysis, design, development, implementation, and evaluation.

3 METHODOLOGY

3.1 Research methodology

This study aims to develop PWA. The researcher applied the ADDIE Model to the system development process. This flexible model is well-suited for developing educational systems efficiently. The development process includes the following steps: analysis, design, develop, implement, and evaluate, as shown in Figure 4 [14], [22], [23].

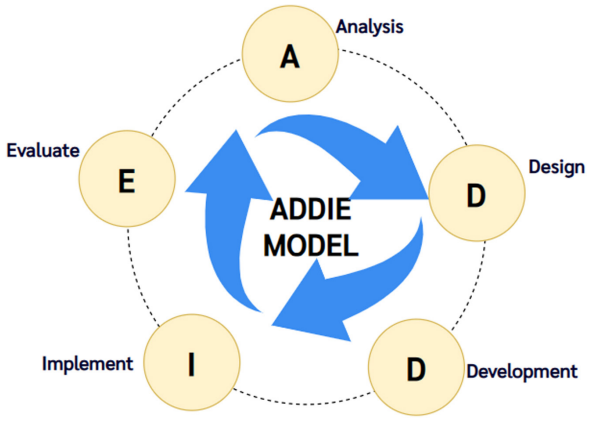

Fig. 4. ADDIE model

A) Analysis

In the analysis phase, the needs and issues of professional experience training were identified. The primary requirements include the following user groups:

Administrators: Manage student data throughout the entire process, from registration to completion.

Supervising instructors: Search and verify student and enterprise information, supervise students, and record their grades.

Students: Check and update personal information and monitor their own grades.

B) Design

In the design phase, user requirements for each group are analyzed and incorporated into the design. This phase results in the system architecture, the workflow, as shown in Figure 5, and the E-R diagram, as shown in Figure 6.

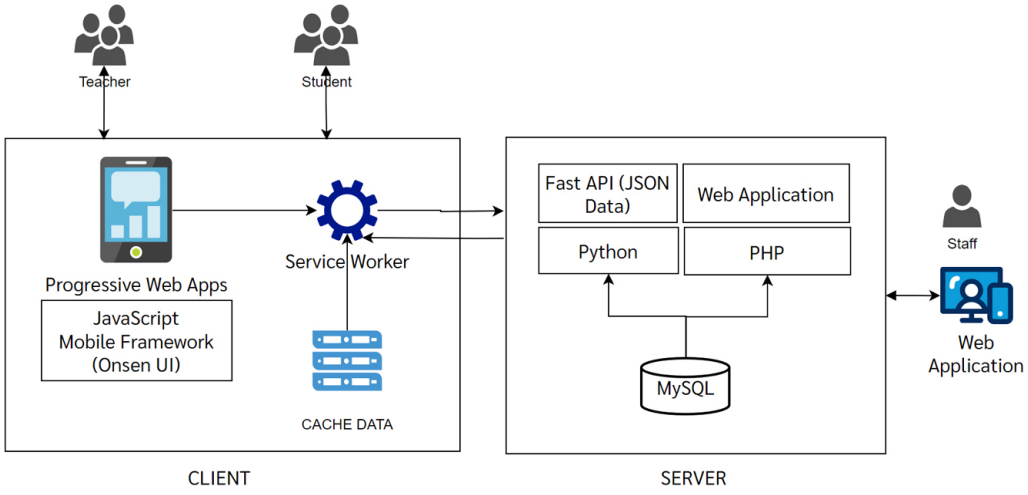

Fig. 5. System architecture

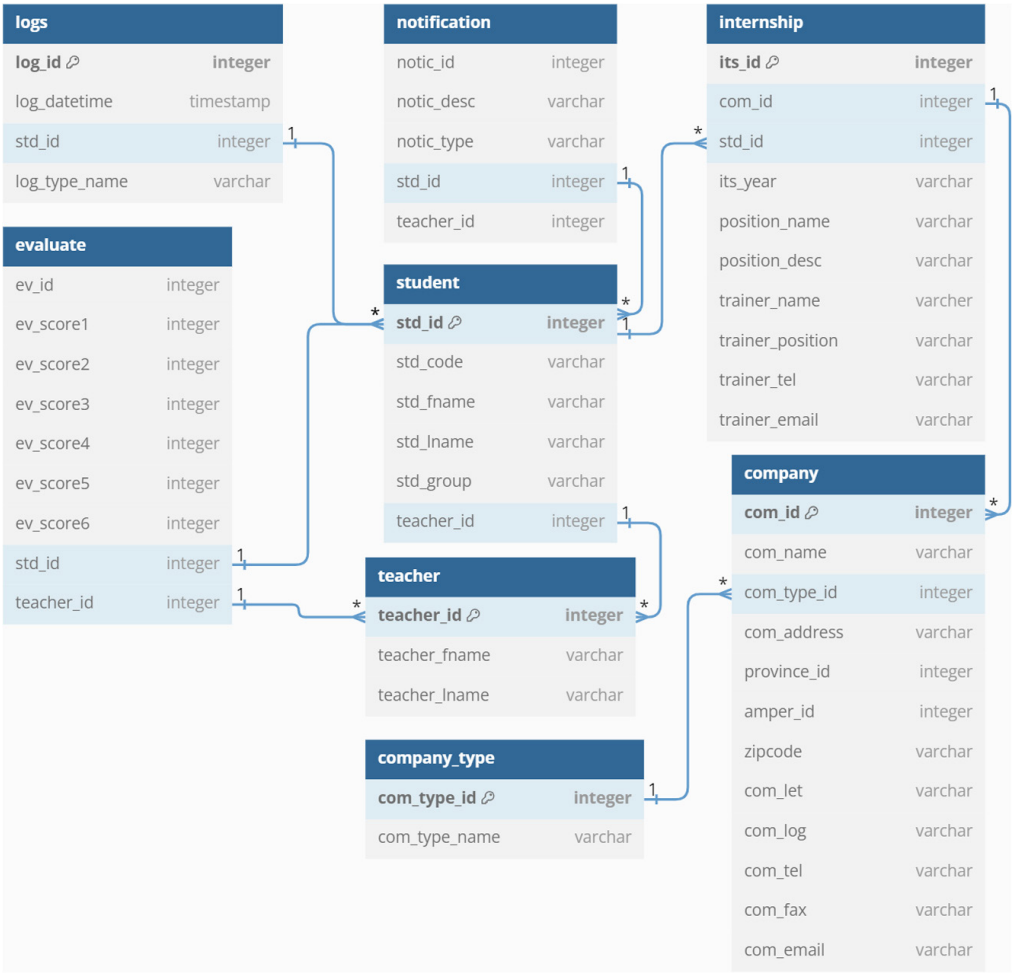

Fig. 6. E-R diagram

C) Development

In the development phase, the design information is used to develop the PWA. This is divided into:

Front end: The researcher utilized PWA technology combined with the mobile framework OnsenUI to ensure that the display is appropriate for different devices.

Back end: The researcher developed the data management system as a web application accessible through the internet. The student internship management system was developed using PHP and connected to a MySQL database.

Micro service API: To enable the PWA to interact with the database, the researcher developed a micro service API using the python framework FastAPI, ensuring convenience, speed, and security. [24], [25] as shown in Figure 7.

Fig. 7. Python FastAPI

D) Implement

In the implementation phase, once the development is complete, the PWA is deployed and used on mobile devices such as smartphones and tablets with the sample group.

E) Evaluate

After the system development, it will be evaluated using performance assessment tools and user satisfaction surveys. The researcher designed the instruments to ensure alignment between the questions and the objectives (index of item objective congruence: IOC) [26], evaluated by five experts. The analysis results of the questionnaire's congruence index showed a consistency (IOC) value of 0.90. Its performance and user satisfaction are evaluated using statistical methods, including mean and standard deviation, for analysis and evaluation [27].

Mean score of 4.51–5.00 indicates very high
Mean score of 3.51–4.50 indicates high
Mean score of 2.51–3.50 indicates moderate
Mean score of 1.51–2.50 indicates low
Mean score of 1.00–1.50 indicates very low

3.2 Research population and sample

The study population consists of: 1) 1,100 students from the Faculty of Management Science at Nakhon Si Thammarat Rajabhat University, and 2) 65 faculty members.

The study sample was selected using purposive sampling with the following details:

1. 90 fourth-year students majoring in management who are currently undergoing professional experience training. These students were selected because they have sufficient experience and knowledge to assess the system's performance and express their satisfaction with its use. This group was chosen as they are directly involved with the developed system, making the research findings consistent with the target group of the study.
2. 12 faculty members from the management program who have expertise and play a role in managing and evaluating the professional experience training of students. These faculty members are responsible for providing guidance and improving the training process, allowing them to offer valuable and in-depth insights for the research.
3. Five experts in information system development and application development were selected for their expertise in designing and developing information systems. This group can provide feedback and evaluate the technical performance of the developed system, contributing to the completeness and robustness of the research in system development.

4 RESULTS

4.1 Results of the system design and development

Font end. Supervising instructors can login to the system to verify the list of students they need to supervise and review essential details for the supervision, such as the internship location, contact number, enterprise mentor, and route map. After completing the supervision, instructors can evaluate and grade the students as shown in Figures 8 and 9.

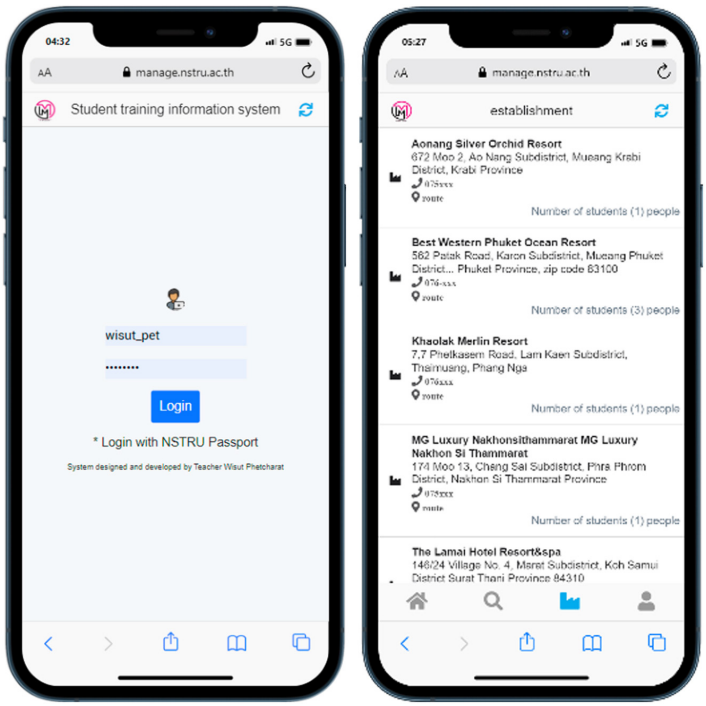

Fig. 8. Display screen for supervising instructors

From Figure 8, supervising instructors can login to the system using their university username and password. They can check the list of students currently undergoing professional experience training at various enterprises and click to view important details such as contact numbers, internship locations, student supervisor contact numbers, maps for travel, and navigation directions.

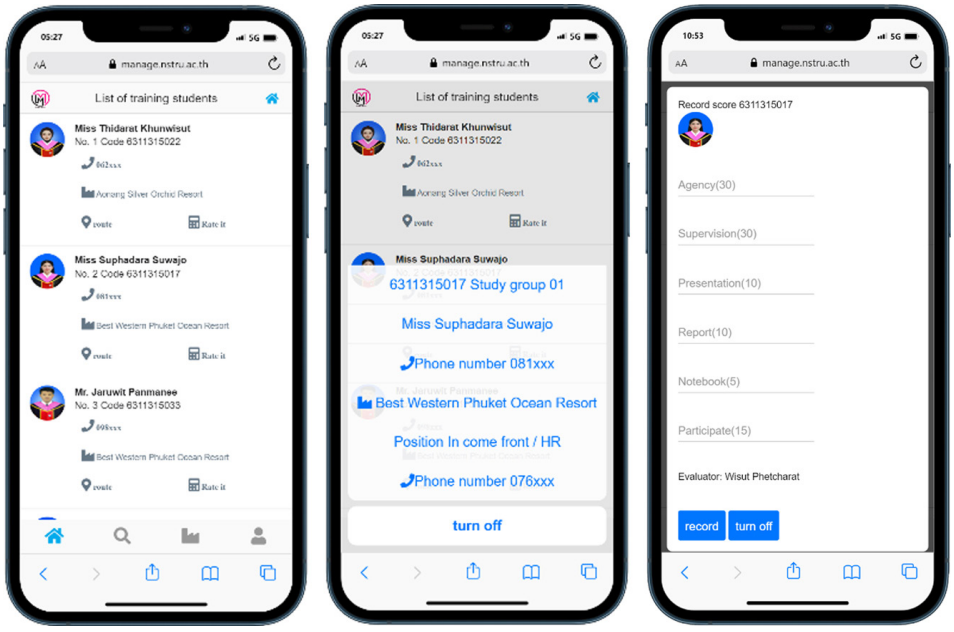

Fig. 9. Display screen for supervising instructors

From Figure 9, supervising instructors can search for and select student information and record individual grades immediately.

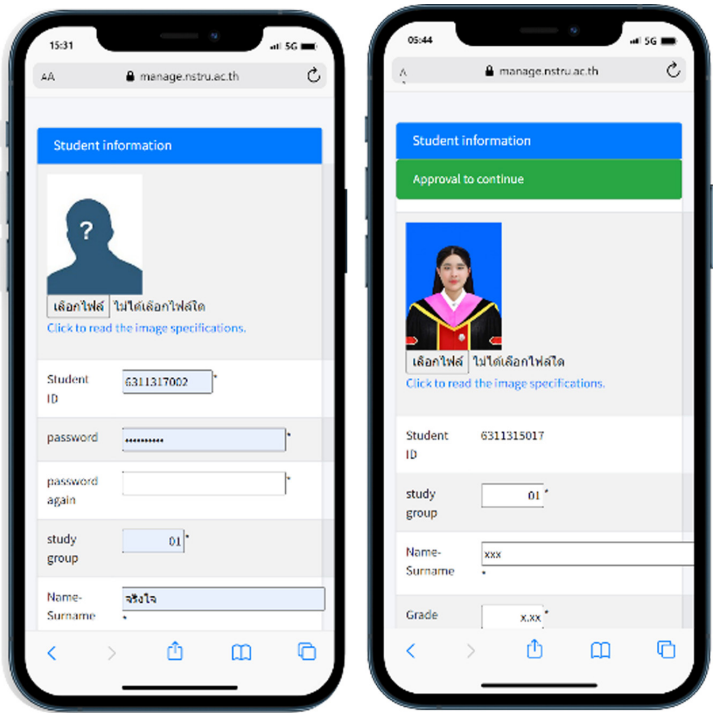

Fig. 10. Display screen for student

From Figure 10, students can login to the system to edit, update, and verify their own information, as well as check the grades given by their supervising instructors.

Back end. Supervising instructors can manage the information of students undergoing professional experience training through the web interface. They can review the evaluation results, verify grades, and submit the academic results accordingly, as shown in Figure 11.

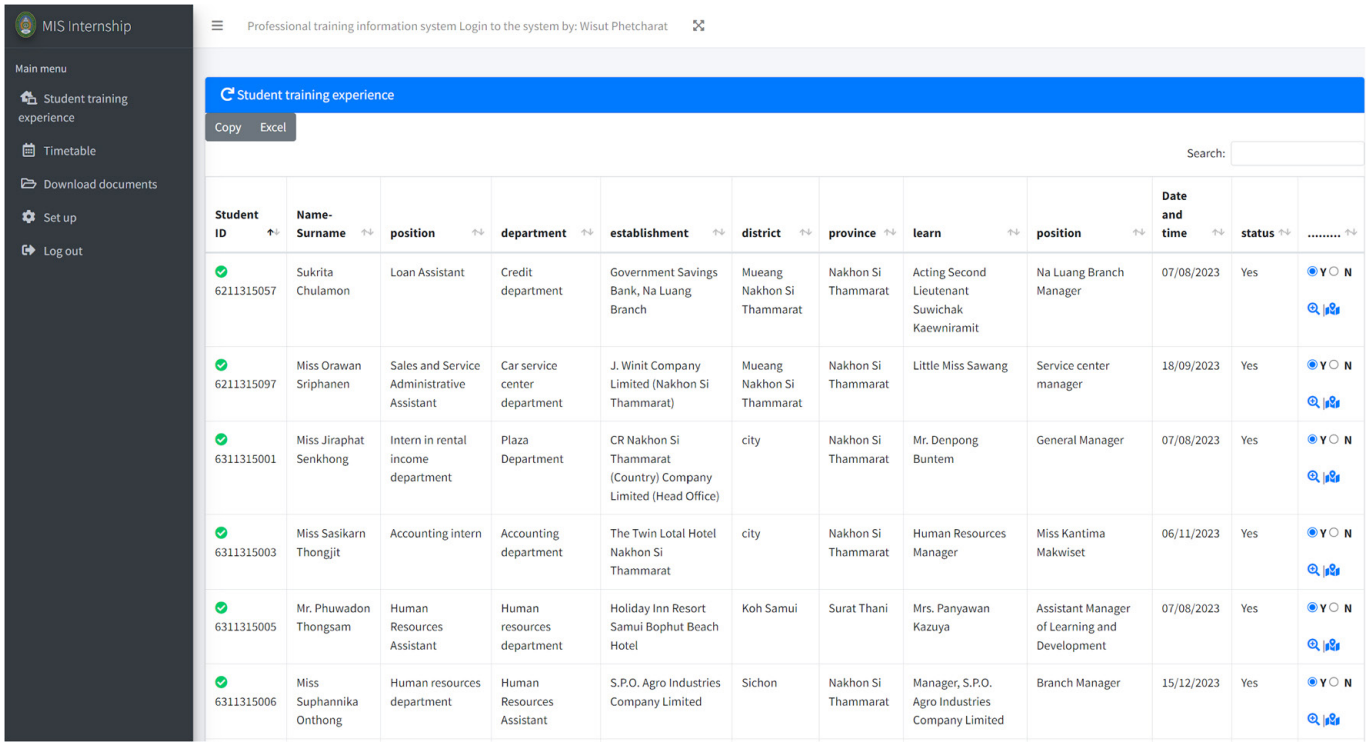

Fig. 11. Display screen check evaluation result

4.2 Evaluation results

Table 1. Evaluation results of the system's efficiency by experts

Item	Item Content	Mean	SD	Rank
1	Ease of Use	4.80	0.50	very high
2	Data Security	4.79	0.53	very high
3	System Function	4.73	0.49	very high
4	Requirement	4.72	0.50	very high
Average		**4.76**	**0.51**	**very high**

Based on Table 1, the evaluation results of the system's efficiency by five experts to assess its effectiveness revealed the following: the highest mean score was for ease of use at 4.80, followed by data security at 4.79, system functionality at 4.73, and meeting requirements at 4.72, respectively. The overall mean efficiency score was at a very high level, 4.76.

Table 2. Evaluation results of user satisfaction

Item	Item Content	Mean	SD	Rank
Components				
1	Appropriate font size and numerals	4.74	.40	very high
2	User-friendly layout and menu	4.75	.50	very high
3	Display results suitable for the device	4.80	.40	very high
4	Aesthetic, modern, and interesting appearance	4.73	.50	very high
Components Average		**4.76**	**.45**	**very high**
User Experience				
5	Swift installation process	4.85	.53	very high
6	Convenient and secure system login	4.88	.44	very high
7	Efficient and accurate performance	4.80	.54	very high
8	Operates and displays results similar to an application	4.85	.43	very high
User Experience Average		**4.85**	**.49**	**very high**
Utility				
9	System Beneficial for directing students in practical experience	4.80	.49	very high
10	System Beneficial for evaluating the performance of internship students	4.80	.63	very high
Utility Average		**4.80**	**.56**	**very high**
Average		**4.80**	**.50**	**very high**

Based on Table 2, the evaluation results of user satisfaction from a sample of 102 individuals revealed the following: the highest mean score was for usability at 4.85, followed by utility at 4.80, and components at 4.76, respectively. When considering individual items, the highest mean score was for ease and security of system access at 4.88, followed by functionality and display consistency with the application, and installation speed, both at 4.85. The suitability of the display for devices, speed, and accuracy all had mean scores of 4.80, as did the utility in supervising and evaluating student interns. The menu layout's ease of use had a mean score of 4.75, followed by the appropriateness of font and number sizes at 4.74, and the attractiveness, modernity, and interest at 4.73. The overall mean user satisfaction score was at a very high level, 4.80.

5 DISCUSSION

5.1 System development results

The PWA for Student Internship Management system was developed using the ADDIE Model. The system was systematically designed and developed to meet user requirements, undergoing the analysis, design, development, and implementation phases. This systematic approach resulted in a highly usable and practical system. This process aligns with the research of authors [11] on the development of Android-based computer and basic network learning media using the ADDIE model, where

the system effectively supported teaching in computer and basic network courses. The PWA for Student Internship Management system, developed with PHP and the Onsen UI Framework, supports cross-platform functionality without needing installation. The system's functions are divided into two parts:

a) Students: Students can use the system to apply for internships, check approval statuses, receive announcements and notifications, and view internship evaluations. The system, accessible via Google API OAuth, performs well on mobile devices, as reflected in the highest mean score for ease and security of system access (4.88), functionality and display consistency (4.85), and suitability for devices (4.80).

b) Teachers or supervising instructors: Teachers can approve internships, publish announcements, retrieve student and internship location data, supervise internships, and evaluate student performance. The developed system supports efficient operations, as evidenced by expert evaluations and user satisfaction ratings of 4.76 and 4.80, respectively.

5.2 Expert evaluation results

The system's overall efficiency was rated very high, with a mean score of 4.76. The ADDIE Model's systematic approach resulted in a system that closely met user needs, with very high ratings in all areas. The highest mean score was for ease of use (4.80), followed by data security (4.79). This was achieved by integrating the python Fast API for rapid and convenient API creation, enhancing data exchange security with PWA using token-based authentication. This aligns with the research of authors [17], who utilized microservices for data transfer to PWA. The system's functionality and requirements adherence received mean scores of 4.73 and 4.72, respectively. However, security remains a critical issue, as some APIs lack clear access policies, requiring improvements to prevent unauthorized data access.

5.3 User satisfaction results

The user satisfaction was very high, with an overall mean score of 4.80. Students could easily log in, apply for internships, check approval statuses, receive announcements, and view evaluations. The system allowed students to use it conveniently and securely, enabling them to follow up on news and report their internship progress at any time. They were also able to contact and consult with their supervising instructors throughout their internships, reducing communication issues. This ensured that students could complete their internships on schedule, which helped reduce dropout rates during the internship period.

Teachers could efficiently search for and display student data, as well as evaluate performance. This allowed instructors to conveniently manage and monitor students through the PWA, send notifications, track progress, and assess internship performance, thereby increasing the efficiency of managing student internships. The highest mean score for usability, 4.85, and the system's utility in evaluating internships, which scored 4.80, support this claim. The system's user-friendly access via Google API OAuth and its effective display on mobile devices without requiring installation reflect its cross-platform efficiency. This aligns with the research by the authors [24], who developed a PWA for cross-platform application development.

The system, developed with the Onsen UI Framework, demonstrated high speed and display quality similar to conventional applications.

However, certain aspects such as menu arrangement (4.75), font size (4.74), and aesthetic appeal (4.73) received slightly lower scores, indicating room for improvement in terms of speed and display consistency across different operating systems.

6 CONCLUSIONS AND FUTURE WORK

Key findings: The study on enhancing the efficiency of internship management through the implementation of PWA presents significant findings. The system was developed using the ADDIE Model, resulting in a product that effectively meets the users' needs. The system was built with the OnsenUI Mobile Framework in combination with PHP, and it is implemented as a PWA, efficiently supporting cross-platform functionality. The system demonstrates excellent display performance in terms of speed and quality, comparable to conventional applications. It facilitates the management and evaluation of student internships by providing convenience and speed, effectively serving the target user group. Additionally, it reduces the installation steps for students and faculty, enhancing the efficiency of communication, tracking, reporting, and evaluation processes, all of which can be accomplished through the PWA. Moreover, it helps in reducing the development costs associated with creating applications that support different user platforms.

Recommendations for application: The PWA development approach can be applied to other systems that require rapid use without installation, such as self-ordering systems, systems for the elderly, or devices with limited memory capacity. Additionally, it can be adapted for use in other university departments that conduct similar professional internship programs.

Suggestions for future research: Future research should focus on developing PWA using more advanced frameworks that can support internal device functionality and offer more diverse and aesthetically pleasing displays. Additionally, enhancing the security of PWA should be a priority. Furthermore, research should be conducted with larger sample sizes to further test the capabilities and limitations of Progressive Web App.

7 ACKNOWLEDGMENTS

This study was supported by the Faculty of Management Science at Nakhon Si Thammarat Rajabhat University, and I express gratitude to the Program in Management for providing essential information. Special thanks also go to the students, professors, and experts for their data, information, and valuable advice.

8 REFERENCES

[1] Ministry of Education, "Higher Education Act 2019," Ministry of Education. Accessed: Aug. 20, 2022. [Online]. Available: https://www.mhesi.go.th/images/2563/pusit/legal-all/1p2562.pdf

[2] Nakhon Si Thammarat Rajabhat University, "Subject: General Education Subjects 2011," Registration office. Accessed: Sep. 25, 2022. [Online]. Available: http://regis.nstru.ac.th/regis_web2016/save_file.php?pathatt=fileups&file_name=28_Document.pdf

[3] Nakhon Si Thammarat Rajabhat University, "Regulations of Nakhon Si Thammarat Rajabhat University Concerning the provision of bachelor's degree education 2017," Registration office. Accessed: Oct. 02, 2022. [Online]. Available: https://race.nstru.ac.th/nstru_portal/personnel_section/resources/file_download/1515663272.pdf

[4] Electronic Transactions Development Agency, "Thailand Internet User Behavior 2022." [Online]. Available: https://opendata.etda.or.th/ [Accessed: Sep. 11, 2023].

[5] Ministry of Digital Economy and Society, "The 2023 Household Survey on the Use of Information and Communication Technology."

[6] B. Aprilia, M. Paristiowati, and M. Japar, "'Let's Go,' A mobile learning application for social studies subjects: Prototype of application development," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 17, no. 23, pp. 105–124, 2023. https://doi.org/10.3991/ijim.v17i23.43877

[7] O. Adetunji, C. Ajaegbu, N. Otuneme, and O. J. Omotosho, "Dawning of Progressive Web Applications (PWA): Edging out the pitfalls of traditional mobile development," *American Scientific Research Journal for Engineering, Technology, and Sciences*, vol. 68, no. 1, pp. 85–99, 2020.

[8] S. Huber, L. Demetz, and M. Felderer, "A comparative study on the energy consumption of Progressive Web Apps," *Information Systems*, vol. 108, p. 102717, 2022. https://doi.org/10.1016/j.is.2022.102017

[9] Hanafi, N. H. Adi, A. B. Kusuma, and S. K. Le, "Development of web-based computer laboratory management information system at SMKS Pertiwi Batam," *Journal of Computer-Based Instructional Media*, vol. 1, no. 2, pp. 54–67, 2023. https://doi.org/10.58712/jcim.v1i2.107

[10] A. Fortuna, Waskito, Purwantono, A. Kurniawan, W. Andriani, and M. Alimin, "Designing learning media using augmented reality for engineering mechanics course," *Journal of Engineering Researcher and Lecturer*, vol. 2, no. 1, pp. 18–27, 2023. https://doi.org/10.58712/jerel.v2i1.20

[11] D. P. Putra, A. T. Devega, and Afrina, "Design of a web-based information system for domestic sea transportation services for limited liability company goods," *Journal of Computer-Based Instructional Media*, vol. 2, no. 1, pp. 20–30, 2024. https://doi.org/10.58712/jcim.v2i1.128

[12] F. Prasetya, "Revolutionizing CNC Lathe education: Designing instructional media integrated using augmented reality technology," *TEM Journal*, vol. 13, no. 2, pp. 1695–1701, 2024.

[13] Waskito, A. Fortuna, F. Prasetya, R. E. Wulansari, R. A. Nabawi, and A. Luthfi, "Integration of mobile augmented reality applications for engineering mechanics learning with interacting 3D objects in engineering education," *International Journal of Information and Education Technology*, vol. 14, no. 3, pp. 354–361, 2024.

[14] A. S. Sansi, F. Rini, T. Mary, and T. T. Kiong, "The development of Android-based computer and basic network learning media," *Journal of Computer-Based Instructional Media*, vol. 1, no. 2, pp. 44–53, 2023. https://doi.org/10.58712/jcim.v1i2.19

[15] P. Panichkul, L. Kuikaew, and A. Sooklueang, "Online management information system of the cooperative education and professional experience internship, faculty of business administration and accounting, Sisaket Rajabhat University," *Journal of Management and Development Ubon Ratchathani Rajabhat University*, vol. 6, no. 1, pp. 135–152, 2019.

[16] N. Saetang and K. Tritrakan, "The development of information system for internship and evaluation of the establishments," *Journal of Information*, vol. 22, no. 1, pp. 44–58, 2023.

[17] D. Jhala, "A study on progressive web apps as a unifier for native apps and the web," *International Journal of Engineering Research & Technology*, vol. 10, no. 5, pp. 207–210, 2021. https://doi.org/10.17577/IJERTV10IS050139

[18] D. Sheppard, *Beginning Progressive Web App Development: Creating A Native App Experience on the Web*. California, CA: Apress Berkeley, 2017. https://doi.org/10.1007/978-1-4842-3090-9

[19] M. Mena, A. Corral, L. Iribarne, and J. Criado, "A progressive web application based on microservices combining geospatial data and the Internet of Things," *IEEE Access*, vol. 7, pp. 104577–104590, 2019. https://doi.org/10.1109/ACCESS.2019.2932196

[20] R. Fransson and A. Driaguine, "Comparing progressive web applications with native android applications: An evaluation of performance when it comes to response time," Thesis, Linnaeus University, 2017. [Online]. Available: https://urn.kb.se/resolve?urn=urn:nbn:se:lnu:diva-64764 [Accessed: Nov. 18, 2023].

[21] R. Fauzan, I. Krisnahati, B. D. Nurwibowo, and D. A. Wibowo, "A systematic literature review on progressive web application practice and challenges," *IPTEK The Journal for Technology and Science*, vol. 33, no. 1, pp. 45–58, 2022. https://doi.org/10.12962/j20882033.v33i1.13904

[22] R. M. Branch, *Instructional Design: The ADDIE Approach*. New York, NY: Springer, 2009. https://doi.org/10.1007/978-0-387-09506-6

[23] N. Ratnawati, A. Purnomo, N. Wahyuningtyas, F. Bashofi, and A. H. bin M. Dawi, "Effectiveness of team-based project integrated e-books in improving student self-directed learning and creativity," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 17, no. 24, pp. 136–152, 2023. https://doi.org/10.3991/ijim.v17i24.45955

[24] T. Zabir Khan, "An undergraduate internship on building a remittance service with FastAPI at GoZayaan," Independent University, Bangladesh, Technical Report, Sep. 2023. Accessed: Feb. 08, 2024. [Online]. Available: http://ar.iub.edu.bd/handle/11348/663

[25] J. Chen, "Application technology of atmospheric dispersion models based on FastAPI+Vue," *Academic Journal of Engineering and Technology Science*, vol. 6, no. 11, pp. 120–126, 2023. https://doi.org/10.25236/AJETS.2023.061118

[26] S. Nuanmeesri, "The augmented reality for teaching Thai students about the human heart," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 6, pp. 203–213, 2018. https://doi.org/10.3991/ijet.v13i06.8506

[27] T. Kongjai, "The development of web application for reporting individual exam scores for Chiang Mai University students," *Journal of Information Science*, vol. 41, no. 2, pp. 1–14, 2023. https://doi.org/10.14456/JISKKU.2023.9

9 AUTHORS

Wisut Petcharat is a Lecturer at the Program in Digital Business Computer, Faculty of Management Science, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat, Thailand. His research interests include information and communication technology, education technology, information management, computer programming, and business management (E-mail: wisut_pet@nstru.ac.th; ORCID: https://orcid.org/0000-0002-0165-4183).

Taechita Sutthirak is a Lecturer at the Program in Management, Faculty of Management Science, Nakhon Si Thammarat Rajabhat University, Nakhon Si Thammarat, Thailand. She research interests include business management, financial management, education technology, and information management (E-mail: taechita_sut@nstru.ac.th; ORCID: https://orcid.org/0000-0002-5787-2868).