Global Scientific JOURNALS
GSJ: Volume 14, Issue 1, January 2026, Online: ISSN 2320-9186
www.globalscientificjournal.com

SMOT-APP: SMART OPTICAL TOKEN INTEGRATION FOR CAMARINES SUR POLYTECHNIC COLLEGES

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Abstract

This study focused on the development and implementation of the SmOT-App system, a web-based appointment platform integrating smart optical tokens (SOT) and single sign-on functionality for Camarines Sur Polytechnic Colleges. The system was designed to enhance appointment management across multiple offices, incorporating features such as appointment scheduling, real-time slot availability, secure check-ins via QR code scanning, automated notifications, and role-based user access. The development followed the Agile methodology, progressing through planning, requirements gathering, user design, development, testing, and deployment phases. The system's quality and performance were evaluated by 12 office personnel and 10 IT experts, using ISO/IEC 25010 standards as a benchmark.

The study found that the system successfully implemented a database through the Entity Framework, efficiently managing applicant accounts and submitted documents while ensuring security and accuracy. Role-based access and automated dashboards allowed users, including applicants, school heads, and committee members, to perform tasks securely and efficiently, supporting standardized and transparent assessments. The Administrative Dashboard provided centralized monitoring of appointments and token usage, improving oversight, operational control, and scalability for multiple departments. Scenario-based functional testing confirmed that core features - including token verification, real-time scheduling, and automated notifications - performed reliably and securely. Overall, the SmOT-App system met ISO/IEC 25010 standards, achieving an overall weighted mean rating of 4.87, demonstrating high functionality, usability, reliability, security, maintainability, and portability suitable for practical deployment.

In conclusion, the system successfully streamlined applicant registration, document handling, appointment scheduling, and administrative oversight. Recommendations include regularly backing up the database, enhancing security measures, updating user roles with corresponding training, expanding dashboard capabilities for multiple departments, and continuously evaluating and refining the system against ISO standards to maintain high-quality performance, usability, and reliability. These measures ensure the SmOT-

App remains a secure, efficient, and scalable solution for the institution.

Based on these conclusions, the study recommended regular database backups, continuous monitoring and updating of user roles, periodic evaluation of system performance against ISO standards, and expansion of dashboard capabilities to support multiple departments. These measures ensure the SmOT-App remains secure, efficient, and scalable while maintaining high-quality service for both users and administrators

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Keywords: Authentication System, Campus Access Management, Digital Tokenization, Educational Technology, Information Systems Development, Optical Token Integration, Secure Transaction System, and Smart Optical Token.

Introduction

Technology-driven, educational institutions are now adapting the technology that can be offered to improve and modernize the process (Enrollify, 2025). With the increasing student enrollees in educational institutions, new technology must be adopted to cater and address the challenges such as delays, wasted time and long queues for the students to request a document and transact at the offices.

In traditional and very generic appointment systems, students need to physically at the service office, line up to secure a queue number, and wait - without any guarantee that they will be served on the same day. This contributed to the wastes time, creates stress, and adds to the workload of staff who struggle to manage walk-in traffic. This stress that leads to frustration and becomes dissatisfaction for the service being availed.

To address these challenges, many institutions not only education have started adopting digital appointment systems. These platforms allow students to schedule services online, check availability, and manage queues more efficiently. However, most existing are generic one, they just appoint or select date and time which still has a loophole in their booked schedule, at the service office the guard or personnel in-charge need to make a queue line to be organized. Also still lack security in terms of real-time verification, which is important to ensure that only authorized users can access services and that appointment flows remain organized

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This study introduces a web-based appointment system that uses Smart Optical Tokens (SOTs), a more advance QR code system compares to traditional or plain QR code. Students can book appointments remotely, view available slots, and receive a unique token for entry at the school premise for their verification of their appearance. The SOT ensures security and reliability, helping student's access services without long lines while reducing the workload of staff

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The main objective of this research is to replace the outdated queuing practices at Camarines Sur Polytechnic Colleges with a digital, student-centered solution. The system saves students time, lightens the responsibilities of administrators, and promotes a more organized, data-informed approach to service delivery.

Specific Objectives

Specifically, the study aimed to:

1. **Develop the main features of the SmOT-App system, focusing on:**
   1.1 Appointment Scheduling
   1.2 Real-Time Slot Availability
   1.3 Smart Optical Token (SOT) Generation
   1.4 One-Time Token Use and Expiration Control
   1.5 Paperless and Contactless Transactions

2. **Create system modules that will:**
   2.1 Provide Secure Check-In via Code Scanning
   2.2 Enable Automated Notifications and Reminders
   2.3 Support Role-Based User Access
   2.4 Generate Reports for administrative use

3. **Design and implement an Administrative Dashboard that will:**
   3.1 Allow monitoring of appointments and token usage
   3.2 Provide management tools for staff and administrators
   3.3 Support scalability for multiple departments

4. **Validate the system's core features,** particularly token verification, real-time scheduling, and automated notifications, through scenario-based functional testing.

5. **Evaluate the system using ISO/IEC 25010 standards in terms of:**
   5.1 Functional Suitability
   5.2 Performance Efficiency
   5.3 Compatibility
   5.4 Usability
   5.5 Reliability
   5.6 Security
   5.7 Maintainability
   5.8 Portability

Scope and Delimitations

The study focused on the development, implementation, and evaluation of the *SmOT-App: Smart Optical Token Integration for Camarines Sur Polytechnic Colleges*. Specifically, it aimed to design and build the system's core features, which included appointment scheduling, real-time slot availability, Smart Optical Token (SOT) generation, one-time token use with expiration control, and fully paperless and contactless transactions. System modules were developed to support secure check-in through code scanning, automated notifications and reminders, role-based user access, and report generation for administrative use. Furthermore, an

administrative dashboard was designed and implemented to monitor appointments and token utilization, provide management tools for staff and administrators, and ensure scalability across multiple departments. The system's primary functionalities - including token verification, real-time scheduling, and automated notifications - were validated through scenario-based functional testing. Finally, the system was evaluated using ISO/IEC 25010 standards in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, with assessments conducted by ten IT experts and ten clients as recommended by the adviser and panel members.

The study was delimited to the development and assessment of the SmOT-App within the context of Camarines Sur Polytechnic Colleges. It covered only the core features and modules identified in the project scope and did not extend to the integration of external systems, third-party platforms, or institution-wide digital transformation initiatives beyond appointment and token management. User participation was limited to the selected ten IT experts and ten clients endorsed by the adviser and panel, and the evaluation focused solely on the ISO/IEC 25010 quality characteristics included in the study. The system was tested using controlled scenarios, which meant that unpredictable real-world factors - such as fluctuating network conditions or large-scale institutional deployment - were not part of the investigation. Additionally, the study did not include mobile hardware performance comparisons, long-term analytics usage, or cross-campus expansion, as these were considered outside the project's defined scope and resources.

Gap Bridged by the Study

The reviewed systems primarily focused on using QR codes, digital tokens, and automated notifications to streamline access, attendance, and service management. They shared similarities in implementing contactless validation, real-time updates, and improved operational efficiency. Most systems reduced manual processing, enhanced security, and allowed administrators to monitor usage or attendance digitally. These features demonstrated the benefits of integrating QR-based solutions in educational, municipal, healthcare, and event environments.

The present study was unique in combining smart optical token generation, one-time token use with expiration control, and a fully integrated appointment scheduling platform tailored for a university setting. It bridged gaps by linking token verification, real-time slot availability, and automated notifications into a single system. Unlike prior studies, it included an administrative dashboard with analytics for monitoring appointments and token usage. The system also emphasized scalability, paperless transactions, and secure role-based access, providing a comprehensive solution not addressed in the reviewed systems.

Conceptual Framework

The conceptual framework of the present study focused on the development of the SmOT-App system, which integrated Smart Optical Token (SOT) technology within a web-based appointment platform for Camarines Sur Polytechnic Colleges. The input phase involved several critical activities that guided the system's design and functionality. First, the main features of the SmOT-App were developed to ensure seamless appointment scheduling, real-time slot availability, generation of smart optical tokens, one-time token use with expiration control, and paperless, contactless transactions. These features aimed to streamline the appointment process while enhancing security and efficiency for both users and administrators. Additionally, system modules were created to provide secure check-in through code scanning, automated notifications and reminders, role-based user access, and comprehensive reporting for administrative use. An administrative dashboard was also designed to monitor appointments, track token usage, provide management tools for staff and administrators, and support scalable deployment across multiple departments. To ensure the system's robustness, core features such as token verification, real-time scheduling, and automated notifications were validated through scenario-based functional testing, while the overall system was evaluated according to ISO/IEC 25010 standards, covering functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

The development process followed the Agile Development Methodology, which structured the project into iterative and incremental phases. During the planning phase, project objectives, scope, and resources were defined, setting the foundation for subsequent stages. The requirements phase involved gathering detailed specifications from stakeholders, including the target users and administrators, to ensure the system addressed institutional needs. The user design phase focused on creating intuitive interfaces and workflows that facilitated efficient interaction with the SmOT-App. In the development phase, the system was built using modular coding practices and integrated features according to the identified requirements. Functional and usability testing were performed in the testing phase to identify and resolve errors, validate features, and ensure compliance with ISO standards. Finally, the deployment phase involved implementing the system within the institutional environment, making it accessible to users while allowing administrators to manage and monitor operations effectively.

The output of these inputs and processes was the SmOT-App: Smart Optical Token Integration in a Web-Based Appointment System with Single Sign-On for Camarines Sur Polytechnic Colleges. The system successfully delivered a secure, efficient, and user-friendly platform for appointment management, integrating smart token technology with real-time scheduling and automated notifications. Feedback collected from stakeholders and users highlighted the system's effectiveness in streamlining appointment handling, improving security through token-based authentication, and enhancing administrative efficiency. This iterative feedback loop informed refinements and ensured that the final system aligned with the institution's operational requirements, demonstrating both practical utility and technological innovation in managing appointments and access control.

Findings

The following presents the key findings derived from the study.

1. The study found that the system successfully implemented a database designed through the Entity Framework, which efficiently managed applicant accounts and their submitted documents. The database structure allowed for secure storage, easy retrieval, and organized management of all applicant records, minimizing data redundancy and enhancing operational efficiency. The system incorporated secured applicant and user registration and login functionalities, ensuring that only authorized individuals could access sensitive information. Input validation mechanisms were effectively integrated to prevent errors during data entry, while file upload functions allowed applicants to safely submit required documents. These combined features ensured data accuracy, enhanced the reliability of the registration process, and streamlined document handling for both applicants and administrative staff.

2. The study revealed that the system effectively implemented role-based access, allowing intended users to perform their respective tasks securely and efficiently. Role-based authorization was configured using ASP.NET Core, providing differentiated access levels for applicants, school heads, and other committee members. Automated dashboards were developed for each role, enabling users to manage applications and review submitted assessment evaluation results with ease. Furthermore, the system incorporated an automated and secure evaluation and scoring interface that adhered to the prescribed guidelines of DepEd Order No. 7 s. 2023, ensuring standardized, accurate, and transparent assessment processes across all user roles.

3. The study found that the Administrative Dashboard was successfully designed and implemented to provide a centralized interface for managing and monitoring the SmOT-App system. The dashboard allowed administrators to track appointments in real-time, view token usage, and access detailed reports on user activity, which improved oversight and operational control. Management tools integrated within the dashboard enabled staff to efficiently handle scheduling conflicts, approve or modify appointments, and manage user roles. Additionally, the dashboard was built with scalability in mind, allowing seamless expansion to accommodate multiple departments and increased user load without compromising system performance. Overall, the dashboard enhanced administrative efficiency, improved data visibility, and ensured effective coordination across the institution.

4. The study found that the system's core features were effectively validated through scenario-based functional testing. Token verification was tested to ensure that only authorized users could access services, and one-time token use with expiration control functioned accurately to prevent unauthorized entry. Real-time scheduling was confirmed to update instantly with user bookings, cancellations, or modifications, minimizing conflicts and ensuring smooth appointment management. Automated notifications were also tested and successfully delivered timely reminders, confirmations, and updates to users, enhancing engagement and reducing missed appointments. Overall, the testing demonstrated that the system performed reliably, securely, and in accordance with its intended functionality.

5. The study found that the SmOT-App system met the evaluation criteria set by ISO/IEC 25010 standards across all assessed attributes, achieving an overall weighted mean rating of **4.87**, which is interpreted as **Acceptable**. Functional suitability was confirmed as the system correctly executed appointment scheduling, token generation, and secure check-in processes according to user requirements. Performance efficiency was validated through its ability to handle multiple concurrent users and real-time updates without significant delays. Compatibility was established with different browsers and devices, ensuring seamless access for clients and administrators. Usability assessments indicated that the interface was intuitive, easy to navigate, and accessible for all user roles. Reliability was demonstrated through consistent operation, fault tolerance, and recoverability during testing scenarios. Security evaluations confirmed the protection of user data, authentication integrity, and secure token management. Maintainability was observed through modular code design and ease of updates, while portability was validated by successful deployment across different hardware and operating systems. Collectively, these results indicated that the system adhered to high-quality software standards and was fit for practical implementation.

Conclusions

Based on the findings of the study, the following conclusions are drawn:

1. The system successfully managed applicant accounts and documents, ensuring data accuracy, security, and efficient registration processes.

2. The role-based access and automated dashboards allowed users to perform tasks securely and efficiently while maintaining standardized and transparent assessments.

3. The Administrative Dashboard improved oversight, operational control, and administrative efficiency

while supporting scalability for multiple departments.

4. The scenario-based functional testing confirmed the system's core features operated reliably, securely, and as intended, including token verification, real-time scheduling, and automated notifications.

5. The SmOT-App system met ISO/IEC 25010 standards with an overall rating of 4.87, demonstrating high quality, reliability, security, and usability suitable for practical deployment.

Recommendations

In consideration of the findings and conclusions, the researcher proposes the following recommendations:

1. Regularly back up the database and enhance security measures to ensure safe and efficient management of applicant records.

2. Periodically update user roles and provide training to ensure secure, standardized, and efficient task execution.

3. Continuously monitor and expand the dashboard's features to support multiple departments and improve administrative oversight.

4. Conduct ongoing testing and monitoring to maintain reliable, secure, and timely system operations.

5. Regularly evaluate the system against ISO standards and incorporate improvements to maintain high-quality performance and usability.

6. Regularly back up the database and enhance security measures to ensure safe and efficient management of applicant records, while considering future scalability for increased users.

7. Periodically update user roles, provide training, and review access privileges to maintain secure, standardized, and efficient evaluation processes.

8. Continuously monitor and expand the dashboard's features, integrate advanced analytics, and optimize for multi-department usage to improve administrative decision-making.

9. Conduct ongoing testing, implement monitoring tools, and refine real-time functionalities to sustain reliable, secure, and efficient system operations.

10. Regularly reassess system performance, usability, and security against ISO standards, and incorporate technological updates to maintain high-quality standards and user satisfaction.

References

1. Al Amin, I. H., Lusiana, V., Hartono, B., & Wahyu, D. (2021). QR Code Based Attendance System for Contact Tracking Post Pandemic. CogITo Smart Journal, 10(1), 436–450. DOI:10.31154/cogito.v10i1.490.436-450

2. Alcantara, M., & dela Peña, C. (2022). Web-Based QR Code Attendance System for Schools. *Undergraduate Thesis, University of Santo Tomas.*
3. Ampuan, A. D., & Delena, R. D. (2022). Implementation and Evaluation of Web-Based Appointment System for Mindanao State University – Main Campus. *Journal of Information Systems and Informatics,* 4(4), 922–937. DOI:10.51519/journalisi.v4i4.379
4. Australian Government. 2021. *Australia's Electronic Check-in Guidance via QR Codes.* Canberra, Australia.
5. Capmany, J., & Pérez, D. (2020). Programmable Integrated Photonics. Oxford University Press.
6. Davies, H., Hjorth, L., Andrejevic, M., Richardson, I., & DeSouza, R. (2023). QR Codes during the Pandemic: Seamful Quotidian Placemaking. SAGE Journals. DOI:10.1177/13548565231160623
7. De Guzman, N. B., Alibuyog, M., Baniaga, J., & Estrada, M. (2023). Satisfaction in Using Barcode Attendance for Criminology Students in Laoag City. *Institutional Report.*
8. Del Rosario, A., & Mendoza, J. (2025). QR-Based Visitor Monitoring System for Government Facilities. *Undergraduate Thesis, Polytechnic University of the Philippines.*
9. Dizon, B., Ferrer, L., & Tan, S. (2021). Event Management System with QR-Based Entry. *Undergraduate Thesis, Lyceum of the Philippines University.*
10. Enrollify. 2025. *The Roadmap to Higher Education Digital Transformation.* Enrollify. Retrieved March 17, 2025, from https://www.enrollify.org/blog/higher-education-digital-transformation
11. Farin, M. N. (2024). Acceptability and Usability of Quick Response Code for Online Document Tracking in a Higher Education Institution in the Philippines. *International Journal of Computer Science & Network Security,* 24(11), 133–140. DOI:10.22937/IJCSNS.2024.24.11.15
12. Galgo, J. (2024). Utilizing QR Codes for Smart and Low-cost Student Attendance Acquisition and Monitoring System in Eastern Visayas State University, Philippines. *Technical Brief, ResearchGate.*
13. Gonzalez, A., & Roberts, S. (2023). A Web-Based eHealth Appointment System with Encrypted QR Code Integration for Patient Authentication. International Journal of Medical Informatics, 174, 105062. DOI: https://doi.org/10.1016/j.ijmedinf.2023.105062
14. Gonzalez, J., & Ramirez, C. (2022). User Behavior in Smart Appointment Systems. Journal of Human-Computer Studies, 11(2), 75–84.
15. Grepon, B. G. (2021). Designing and Implementing e-Justice Systems: An Information Systems Approach to Regional Trial Court Case Docket Management in Northern Mindanao, Philippines. *arXiv preprint.*
16. Grepon, B. G., Baran, N. T., & Gumonan, K. M. V. (2021). Designing and Implementing e-School Systems for School Management in Northern Mindanao, Philippines. *arXiv preprint (abs/2109.00198).*
17. Guevara, L., & Tangonan, E. (2024). Development of an eHealth Appointment System for Barangay Health Centers. *Undergraduate Thesis, University of the East.*
18. Hunsperger, R. G. (2009). Integrated Optics: Theory and Technology. Springer. SpringerLink
19. Laudza, N. A. S., & Sofyan, H. (2024). Evaluasi kualitas sistem informasi akademik dengan standar ISO/IEC 25010 (Studi kasus: Universitas ABC). Telematika: Jurnal Informatika dan Teknologi Informasi, 21(2), 158–172. Jurnal UPN Veteran Yogyakarta
20. Lee, W., & Huang, M. (2021). QR Ticketing in Smart Metro Systems. Journal of Transportation Innovation, 9(1), 13–22.
21. Lim, D., & Francisco, K. (2024). School Enrollment System with QR Authentication. *Undergraduate Thesis, Mapúa University.*
22. Martinez, F., Santos, M., & De Vera, H. (2023). Online Queueing System for Government Agencies Using QR Authentication. *Undergraduate Thesis, Technological Institute of the Philippines.*
23. Mastercard. 2020. *Contactless Payments: State of the Industry Report.* Retrieved from https://www.mastercard.com
24. Mendoza, H., Alvarez, J., & Ruiz, F. (2021). Smart Entry Logging via QR Tokens in Academic Libraries. Journal of Digital Access and Resource Management, 7(4), 112–119.
25. Mindster. 2025. *Real-Time Scheduling Features That Boost Appointment Apps.* Mindster Blogs. Retrieved June 6, 2025, from https://mindster.com/mindster-blogs/real-time-scheduling-features-appointment-apps/
26. Mori, T., & Kato, N. (2021). One-Time QR Tokens for Secure Vaccine Verification. Health IT Journal, 8(3), 109–116.

27. Nguyen, H. T., & Kim, J. (2021). Design and Implementation of a Contactless Queue and Appointment Management System Using QR Code Technology. Sensors, 21(13), 4459. DOI: https://doi.org/10.3390/s21134459
28. Paculaba, A. M. C., Bathan, M. A. S., & Niego, E. L. (2021). Log Monitoring System Using Quick Response (QR) Code for COVID-19 Contact Tracing in a Philippine University. *International Journal of Informatics Information Systems and Computer Engineering,* 3(2). DOI:10.34010/injiiscom.v3i2.9037
29. Padilla, C., & Lopez, J. (2021). Barangay Scheduling and QR Access System. *Undergraduate Thesis, Pamantasan ng Lungsod ng Maynila.*
30. Prameswari, A. P. T., & Setyawan, M. Y. H. (2025). Development of a hybrid model for website functional evaluation based on ISO/IEC 25010 and SERVQUAL. Matrix: Jurnal Manajemen Teknologi dan Informatika, 15(1), 32–39. ojs2.pnb.ac.id
31. R., & Olsen, D. (2020). University Booking Systems Using QR Access. Educational Technology Review, 18(4), 23–32.
32. Red Hat. 2024. *What is Role-Based Access Control (RBAC)?* Retrieved from https://www.redhat.com/en/topics/security/what-is-role-based-access-control
33. Reyes, J., & Cruz, A. (2023). Contactless QR Code Access for Library Services. *Undergraduate Thesis, Far Eastern University.*
34. Rezaei, M., & Akbari, L. (2023). Role-Based Access in Healthcare IT. Journal of Cybersecurity Applications, 14(1), 41–50.
35. Ristanto, R. D., Kurniawati, K., Dwinanto, A., & Nawassyarif, N. (2020). Analisis software product quality ISO/IEC 25010 pada pengembangan tes bakat menggunakan sistem computer-based test (CBT). Edu Komputika Journal, 7(2), 49–60. Journal UNNES
36. Secugal, K. A. S., Sermeno, J. P., & Mistio, N. E. (2021). QR Code Tracking & SMS Notification Interface for Scholarship Management System. *International Journal of Applied Science and Engineering,* 18(4).
37. Setiawan, A., & Rahayu, D. N. F. A. (2022). SISENSI: QR Code-based Academic Attendance System. Urecol Journal Part E: Engineering, 2(1), 29–36. DOI:10.53017/uje.141
38. Singh, A., & Reddy, S. (2022). Enhancing Healthcare Queuing Through QR Token Systems. Journal of Public Health Informatics, 10(2), 55–63.
39. Soriano, R., & Yao, V. (2020). QR-Based Confirmation System in Academic Scheduling. *Undergraduate Thesis, De La Salle University.*
40. Tan, K., & Low, M. (2023). Hybrid Biometric and QR Code Systems in Education. Asia-Pacific Journal of Educational Technology, 13(1), 21–30.
41. TechTarget. 2023. *Security Token Definition: One-Time Passwords (OTPs).* TechTarget. Retrieved June 30, 2023, from https://www.techtarget.com/searchsecurity/definition/security-token
42. Torres, L., & Bernardo, P. (2020). Web-Based Municipal Record Request System with QR Validation. *Undergraduate Thesis, Bulacan State University.*
43. ValTrace/StaySafe.ph Collective. (2020). QR Based Contact Tracing Systems in Philippine LGUs. *Philippine Digital Government Report.*
44. Vavoulas, A., Nisiotis, L., & Zervas, P. (2021). QR Patrol: A Real Time Guard Tour System for Enhancing Security Operations. Journal of Information Systems Engineering & Management, 6(1). DOI:10.29333/jisem/9757
45. Wang, B., Hu, H., Guo, X., Xie, Y., & Fang, Y. (2024). Design and Implementation of University Emergency Management System Based on QR Code Scanning and Mobile Terminal. EasyChair Preprint, 15210.
46. Wang, L., & Patel, R. (2024). Smart Campus Entry Control System Using Optical Tokens and Real-Time Notification Services. IEEE Access, 12, 44213–44225. DOI: https://doi.org/10.1109/ACCESS.2024.3359011
47. Winanti, A. N., Haryanto, B., Supiana, N., & Fernando, E. (2024). Integrating QR Code to e-Class System for Managing Attendance Lecture Services in Higher Education. IJIEEB, 16(4), 93–104. DOI:10.5815/ijieeb.2024.04.06
48. Wlodarczak, P. (2025). Agile Software Development. Routledge. Taylor & Francis
49. Wrike. 2017. *What is Agile Methodology in Project Management?* Retrieved July 31, 2025, from https://www.wrike.com/projectmanagement-guide/faq/what-is-agile-methodology-in-projectmanagement/
50. Zhang, Q., & He, Y. (2018). Smart Reservation with Mobile QR Codes. IEEE International Conference on Campus Automation, 80–86. DOI:10.1109/ICCA.2018.8494036

51. Zhang, Q., Li, H., & Zhao, Y. (2020). Secure QR Code Technology for Real-Time Data Exchange. IEEE International Conference on Communication and Networking Technologies (ICCCNT). DOI: https://doi.org/10.1109/ICCCNT.2020.8494036

ACKNOWLEDGEMENT

The researcher extends sincere gratitude and appreciation to the following individuals, whose guidance and inspiration played an invaluable role in the realization of this study:

At *Aemilianum College Inc.,* the researcher is not only afforded the opportunity to become an integral member of the Aemilian community but also to pursue the prestigious MIT degree, thereby enriching both her academic and personal growth. The researcher is profoundly grateful for the invaluable opportunities extended;

Special thanks are extended to *Rev. Fr. Rey Genaro M. Malabanan, CRS,* director of Aemilianum College Inc., *whose* leadership and encouragement have been an unwavering source of inspiration. His commitment to the institution's vision and mission has motivated the researcher to align this study with the values of excellence and innovation;

The researcher wishes to express his sincere gratitude to his adviser, *Mr. Richard G. Rabulan, MIT*, for his *invaluable* guidance and constant support throughout the study. He is especially thankful for the adviser's kindness and timely reminders to always observe punctuality in submitting requirements, particularly during oral defenses;

The researcher wishes to express her heartfelt gratitude to *Dr. Josefina R. Sarmiento*, very supportive dean, for her tireless guidance, unwavering patience, and unparalleled expertise. Her steadfast support and invaluable mentorship have served as a cornerstone of this study's success. The researcher is truly indebted to her for everything she has consistently provided;

The researcher is deeply thankful to the distinguished thesis committee: *Marilyn D. Berdin, MPA; Marneil Allen G. Sanchez, MIT; Milan E. Bausa, MIT; Josefina R. Sarmiento, MIT, PhD;* and *Rev. Fr. Mandee N. Batac, CRS*, for their valuable time, constructive feedback, and insightful recommendations that greatly improved the quality of this study;

To the *IT experts* who generously shared their time, knowledge, and technical expertise, the researcher extends sincere gratitude. Their invaluable insights, constructive feedback, and professional guidance significantly contributed to the

enhancement of the system's functionality, reliability, and overall performance. Their recommendations ensured that the developed system met technical standards and was well-prepared for actual deployment and practical use. Without their support and expertise, the successful completion of this study would not have been possible;

To the researcher's *friends*, heartfelt appreciation is extended for their continuous encouragement, valuable time, and unwavering support throughout the conduct of this study. Their motivation, understanding, and moral support served as a constant source of strength, especially during challenging moments, and greatly contributed to the successful completion of this research;

To the *parents* of the researcher, sincere gratitude is expressed for their unconditional love, guidance, financial assistance, and moral support. Their constant encouragement and sacrifices provided the foundation and inspiration necessary for the successful completion of this study;

To the researcher's beloved family – wife *Sarah Jane Ll. Beriña* and daughter *Rosie Anaaiah* - words cannot fully capture the depth of her gratitude for your unwavering support, unconditional love, and steadfast belief in her capabilities. You have been her rock, her constant source of strength, and her guiding light during moments of doubt and challenge. Your sacrifices, encouragement, and faith in her dreams have been the foundation upon which this achievement stands. Your love and support have inspired her to persevere, push beyond limits, and strive for greater heights. For this, and so much more, she is eternally grateful;

Above all, the researcher is deeply grateful to *God Almighty*, whose divine guidance and blessings have been her constant source of strength and resilience throughout this journey. The grace and wisdom He have provided have been instrumental in the successful completion of this study;

To everyone who has contributed, supported, or inspired in any way, the researcher extends her heartfelt gratitude. This accomplishment is a testament to the collective efforts of those who believed in and supported this endeavor.

Thank you and God bless!

J.M.B. Jr.