Design and Implementation of Full-Stack Conference System for Streamlined Administrative Workflows

Andrew Fernando Pakpahan
Universitas Advent Indonesia; Jl. Kolonel Masturi No. 288, Bandung Barat, Jawa Barat
e-mail: andrew@unai.edu

Abstract

This study presents the design, implementation, and evaluation of the 11ISC Conference Management System (CMS), a full-stack web application developed to address the fragmented administrative workflows of the 11th International Scholars Conference. Using the Design Science Research methodology, the system was created in response to recurring challenges such as manual registration, accommodation and transportation coordination, and the time-intensive preparation of Letters of Acceptance. The CMS was evaluated through blackbox functional testing covering twelve primary use cases, all of which passed successfully, including participant registration, payment verification, automated LoA generation, QR-based check-in, and accommodation assignment. Administrator feedback indicated substantial process improvements, with the automated LoA module reducing preparation time by up to 90 percent and integrated room and check-in management significantly decreasing errors associated with the previous spreadsheet-based workflow. Deployed during the conference, the system supported more than 220 participants and over 180 paper submissions, providing real-time dashboards and unified data management. The results demonstrate that the CMS enhances efficiency, accuracy, and coordination, offering a practical and replicable solution for academic event management in similar institutional contexts.

Keywords— Conference Management System, Design Science Research, Web Application Development, Event Registration System

1. INTRODUCTION

Academic conferences serve as essential venues for disseminating research, fostering collaboration, and expanding professional networks [1], [2]. However, organizing such events requires extensive coordination across paper submission, participant registration, accommodation, transportation, and the issuance of Letters of Acceptance (LoAs) [3]. In many cases, these administrative tasks are handled through a combination of unintegrated platforms, resulting in fragmented workflows that rely on journal systems for submissions, online forms for registration, and various communication channels for logistical arrangements. This fragmented approach often leads to redundant data entry, communication delays, and a significant administrative burden for organizing committees.

Such was the case for the 11th International Scholars Conference (11ISC), an annual event jointly organized by four Adventist higher education institutions in Southeast Asia: Universitas Advent Indonesia (UNAI), Universitas Klabat (UNKLAB), the Adventist University of the Philippines (AUP), and Asia-Pacific International University (APIU). In previous editions, submissions and reviews were managed through email, online forms, and later Open Journal Systems (OJS). However, participant registration, accommodation, transportation, and LoA preparation were handled through a mix of Google Forms, spreadsheets, emails, and messaging applications, resulting in fragmented workflows. Accommodation and transport were tracked manually, and LoAs were created and sent individually. These disconnected processes were time-consuming, prone to error, and difficult to coordinate across institutions, particularly with hundreds of participants involved.

Given these challenges, the systems included in Table 1 were selected based on their prominence in academic peer-review workflows, their coverage in prior comparative studies, and their potential applicability to conference contexts similar to 11ISC. Widely used platforms such as EasyChair [4], OpenConf [5], and HotCRP [6] support submission and review processes but do not address logistical needs such as participant check-in, transportation coordination, or accommodation management [7], [8]. This limitation is also evident in the EasyChair interface, as illustrated in Figure 1, which shows that the platform focuses primarily on submission and review functions and does not include modules for accommodation, transportation, or on-site attendance management. Commercial systems like ConfTool [9] and Ex Ordo [10] offer broader functionality, yet their licensing costs make them difficult to adopt for small to medium-sized conferences in developing regions. Previous research has also introduced custom or extended systems for submission management [11], [12], but these solutions typically require technical expertise and still rely heavily on manual operations [13], [14], [15]. Other platforms, such as CoCon, focus primarily on confidentiality and security in peer review without providing logistical support [16]. As shown in Table 1, none of the existing systems provide the full set of features needed for 11ISC, particularly accommodation, transportation, automated Letters of Acceptance, and QR-based check-in.

Table 1. Feature Comparison of Various Conference Management Systems

System / Research	Submission & Review	Registration	Accommodation	Transportation	LoA Automation	QR Check-in
EasyChair [4]	Yes	Yes	No	No	No	No
OpenConf [5]	Yes	No	No	No	No	No
HotCRP [6]	Yes	No	No	No	No	No
ConfTool [9]	Yes	Yes	Yes (partial)	No	No	No
Ex Ordo [10]	Yes	Yes	Yes	No	Yes	No
OJS [15]	Yes	No	No	No	No	No
Custom System [11], [12]	Yes	No	No	No	No	No
CoCon [16]	Yes	No	No	No	No	No
11ISC CMS (this paper)	No (using OJS)	Yes	Yes	Yes	Yes	Yes

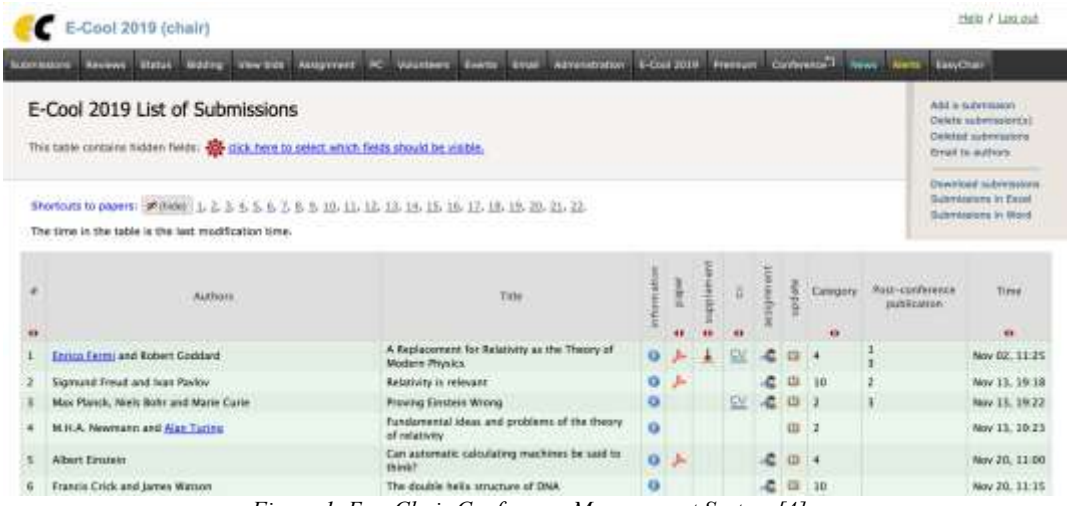

Figure 1. EasyChair Conference Management System [4]

To address the limitations of existing tools, the 11ISC Conference Management System (CMS) was developed to complement Open Journal Systems (OJS), which continues to manage submission, review, and publication. The CMS focuses on the logistical activities that occur after

the review stage, providing functions not supported by OJS. It is a full-stack web application built with Next.js 14 on the frontend and Express.js on the backend, supported by a MySQL database with JWT authentication. The system manages participant registration, accommodation, transportation scheduling, dashboard analytics, and the generation of Letters of Acceptance and QR codes. Its lightweight deployment architecture makes it suitable for institutions with limited IT resources. During the 11th International Scholars Conference, the CMS supported more than 180 paper submissions and 220 participant registrations, and its LoA generation feature replaced manual document preparation and distribution, enabling timely and consistent communication with participants.

Although existing platforms and prior studies provide effective tools for submission and review, they do not address the logistical needs of academic conferences. As shown in Table 1, current systems lack integrated support for registration, accommodation, transportation, automated LoAs, and QR-based check-in. This gap is significant for conferences like 11ISC that involve multiple institutions and large participant numbers. To address this unmet need, this paper presents the design, implementation, and evaluation of the 11ISC CMS as a practical framework that consolidates these logistical processes and improves overall administrative efficiency.

2. RESEARCH METHODS

This study employs the Design Science Research (DSR) methodology to guide the development and evaluation of the 11ISC CMS. DSR, a well-established paradigm in Information Systems research, emphasizes the creation and evaluation of IT artifacts that address real-world organizational problems [17], [18], [19]. As illustrated in Figure 2, the DSR framework comprises three interrelated cycles: the Relevance Cycle, which links the research to practical challenges in conference management; the Design Cycle, involving iterative artifact development and evaluation; and the Rigor Cycle, which anchors the study in existing theories and contributes validated design knowledge. Guided by this framework, the study develops a web-based system to address key operational issues such as fragmented registration and logistics, manual document generation, limited real-time monitoring, and high administrative workload. The resulting CMS provides a unified platform that streamlines workflows, automates processes, and improves overall efficiency. These issues and their corresponding system components are summarized in Table 1, which maps the identified problems to the designed artifacts and associated evaluation methods.

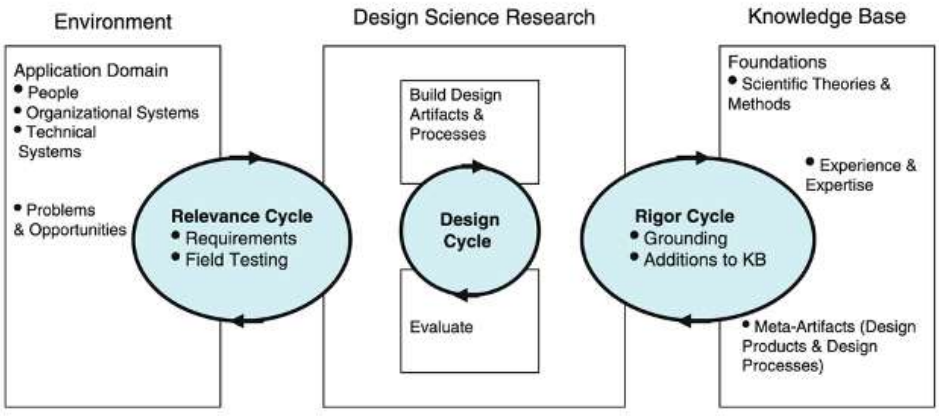

Figure 2. Design Science Research Cycles [17]

Table 1. Mapping of Identified Problems to Designed Artifacts and Evaluation Methods

Problem Area (Relevance Cycle)	Designed Artifact Component (Design Cycle)	Evaluation Method (Rigor Cycle)
Fragmented and inconsistent registration through forms, spreadsheets, and manual emails	Integrated participant registration module with automated confirmation and QR code generation	Blackbox testing of form submission, email delivery, data storage, and QR generation
Manual, time-intensive LoA preparation	Automated LoA generation module with dynamic PDF creation and email dispatch	Functional testing of PDF output and administrator verification during live use
Disconnected accommodation tracking through Excel and messages	Accommodation management module for room preference, allocation, and updates	Scenario-based testing and administrator validation of room assignments
Informal and error-prone transportation coordination	Transportation scheduling module supporting pickup options, terminals, and arrival-time management	Testing with simulated participant arrivals and admin review of assignment accuracy
No unified monitoring of registrations, payments, arrivals, and attendance	Real-time administrative dashboard with statistical summaries	Verification during deployment and cross-checking with registration and check-in data
Long queues and inaccurate attendance lists	QR-based participant check-in module	Live scan tests, real-time updates, and confirmation of attendance logs
Multiple tools required for workflow execution, causing duplicate work and errors	Fully integrated CMS platform connecting registration, logistics, events, and document generation	Administrator interviews and field observations confirming reduced workload and fewer errors

The following subsections elaborate on the Relevance and Design Cycles, while the Rigor Cycle is addressed in the Results section, where the evaluation methods and the application of established design principles are presented.

2.1. Relevance Cycle

The development of the 11ISC Conference Management System (CMS) was motivated by recurring operational inefficiencies observed in previous International Scholars Conferences. Consultations with program chairs, administrators, reviewers, and technical staff revealed fragmented workflows dependent on emails, spreadsheets, and manual document handling. The absence of an integrated system caused communication delays, inconsistent participant data, and coordination difficulties across institutions.

Technically, existing tools lacked automation and interoperability, hindering real-time tracking of submissions, registration, and accommodation. Comparable challenges have been noted in attendance and certificate management systems, where QR-based tracking and automated document generation effectively reduced administrative effort [20], [21].

Iterative field testing and user feedback ensured that the CMS design reflected real-world constraints. Recurrent issues—such as transport miscommunication and manual preparation of Letters of Acceptance (LoAs)—highlighted the need for a unified, automated solution. Table 1 summarizes these challenges and their translation into system requirements that informed the CMS's modular architecture and workflow automation strategy. Table 1 summarizes these challenges and shows how they were translated into system requirements that shaped the CMS's modular architecture and workflow automation strategy.

2.2. Design Cycle

In the design cycle we iteratively built, refined, and evaluated the 11ISC CMS artifact. This process moved from architectural design through prototyping and feedback, culminating in a full-scale demonstration and empirical evaluation of the deployed system.

1.1.1.Architectural Design

The 11ISC Conference Management System adopts a three-tier architecture—frontend, middleware, and backend (Figure 3)—to ensure modularity, scalability, and maintainability.

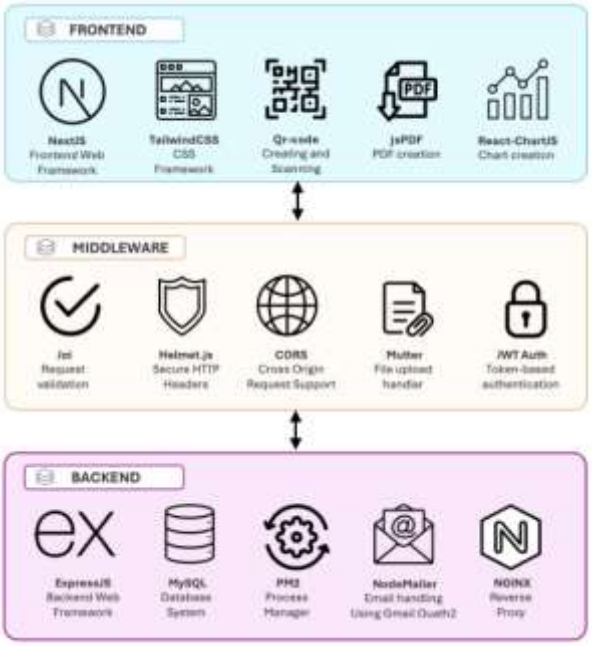

Figure 3. Architectural Design of the 11ISC Conference Management System

- Frontend - The frontend delivers a responsive user experience using Next.js [22] with TailwindCSS for styling. Core features include QR code generation and scanning, automated PDF creation via jsPDF, and real-time data visualization using React-ChartJS. These tools collectively enhance interactivity and administrative visibility.
- Middleware - The middleware layer handles security and data validation. It employs Joi for input validation, Helmet.js for securing HTTP headers, and CORS for cross-origin communication. File uploads (e.g., paper submissions) are processed with Multer, while JWT authentication ensures token-based access control [23].
- Backend - The backend, powered by Express.js [24], [25] and MySQL, hosts the application logic and persistent storage. PM2 maintains process reliability, Nodemailer (via Gmail OAuth2) automates communication, and NGINX serves as a reverse proxy for optimized traffic routing [26].

2.2.1. System Interaction Design

As part of the system design process, a use case model shown in Figure 4 was created to clearly represent how different users would interact with the 11ISC Conference Management System (CMS). This model guided the feature development based on committee needs. The use case diagram focuses on two main types of users: Admin and Participant.

The Admin represents the organizing team members who are responsible for handling key tasks in the system. These tasks include managing paper submissions, participant data, affiliation records, payments, accommodations, transportation, events, and attendance. Several important features were designed specifically to make the admin's work easier, such as generating and sending LoAs, assigning accommodations, and creating participant cards with QR codes for check-in. These tasks used to be done manually using different tools, but the CMS now allows them to be done quickly and consistently within a single platform. The *Participant* uses the system to register, upload payment proof, and check in at the conference. After registration, the system automatically sends a confirmation email and a personalized QR code, which participants use to check in on-site. The payment proof feature also allows admins to verify payments directly

through the system, avoiding long email threads or messaging apps. Moreover, the registration can be opened or closed by the admin using the provided form.

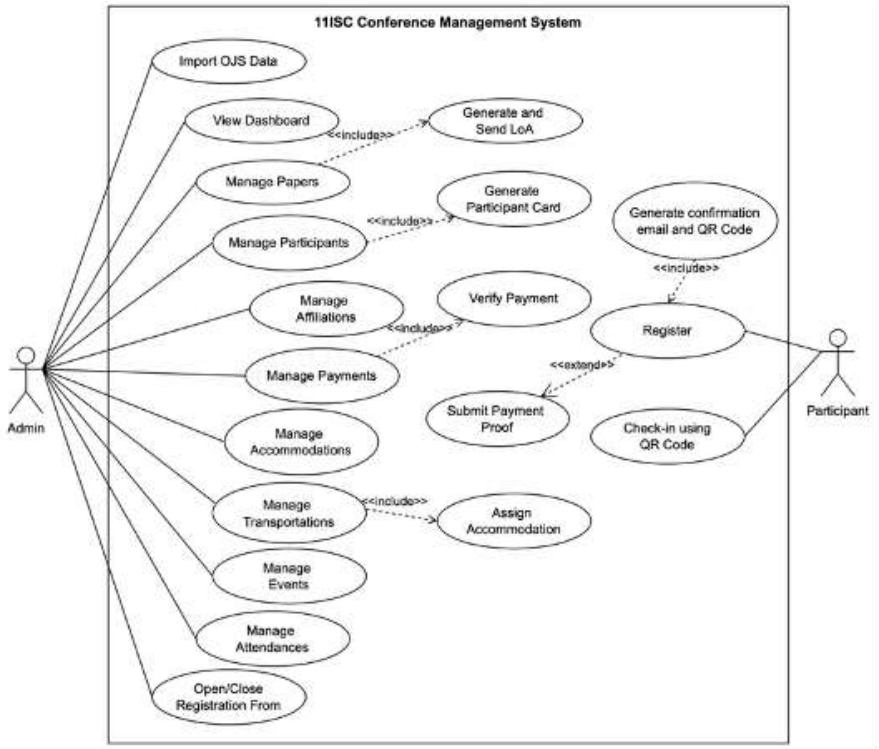

Figure 4. Use Case Diagram of the 11ISC Conference Management System

2.2.2.Database Design

Figure 5 presents the Entity Relationship Diagram (ERD) of the 11ISC CMS database. The schema was designed to support complex interactions among key entities such as *participants (registrations)*, *papers*, *events*, *accommodations*, and *transportation logistics*. Each table is normalized to handle specific tasks; registrations serve as the central entity, linking participant data with papers, accommodations, and event attendance. Related tables such as pickup_options, dropoff_options, and terminals facilitate transport arrangements, while event_attendance tracks participation in specific events. This relational model ensures data integrity, minimizes redundancy, and supports real-time operations critical to managing international academic conferences efficiently.

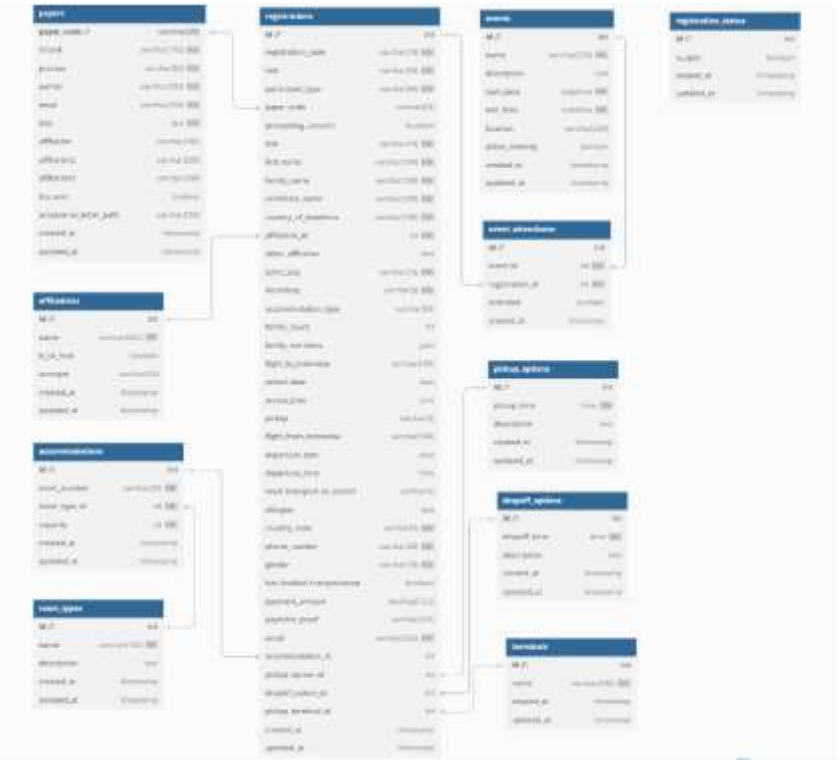

Figure 5. Entity Relationship Diagram of 11ISC Conference Management System

3. RESULT AND DISCUSSION

3.1. Result

This section presents the results of the 11ISC CMS application, including participant registration, accommodation and transportation workflows, LoA generation, QR-based attendance, and administrative dashboards. The system was deployed on an Ubuntu Server 24.04.1 LTS VPS, which provided sufficient capacity for the conference scale of approximately 200 users. Because user access was distributed across different phases of the event, additional scaling mechanisms were not required. Basic server hardening practices were applied, such as enforcing HTTPS, restricting SSH access, configuring the firewall, and performing regular system updates. However, due to space restriction, not all the server logs, forms and pages are included.

3.1.1. Participant Registration Module

The registration form (Figure 6) is designed to capture all essential participant information in a structured and user-friendly format. Participants must first select their role and specify whether they are registering as an academician or a student. If the participant is presenting a paper, the form will require them to enter the corresponding paper code, which can be found in their LoA. The form also collects personal details such as full name, certificate name, affiliation, gender, country of residence, T-shirt size, dietary restrictions, email, and phone number. In addition, it asks about accommodation and transportation preferences.

Figure 6. Registration form of 11ISC Conference Management System

3.1.2. Letter of Acceptance (LoA) Generation

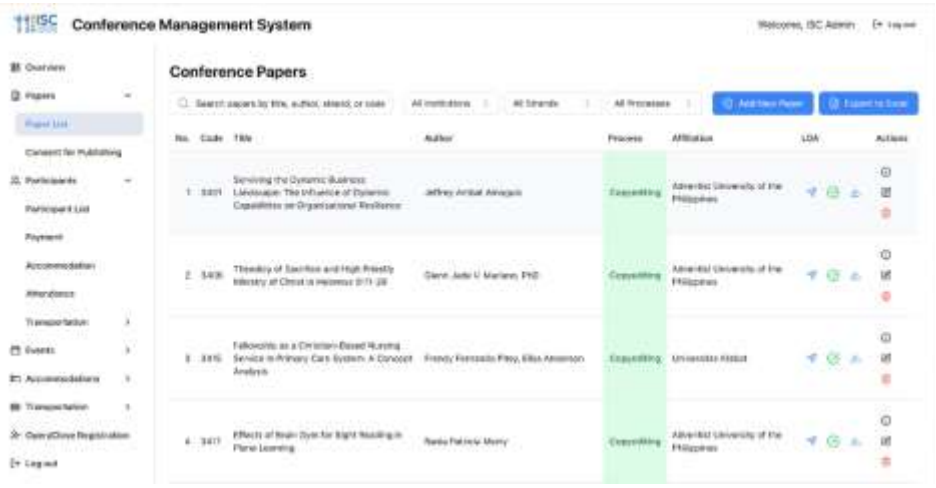

Figure 7. Letter of Acceptance Generation Page 11ISC Conference Management System

Figure 7 shows the admin interface for managing participant data and generating LoA. Upon confirmation of payment, the admin can generate and email the LoA directly from the system. Figure 8 shows the standardized LoA PDF produced by the system, formatted dynamically with participant and paper details.

LETTER OF ACCEPTANCE

Bandung, 17 September 2024

No : 055/ISC11th/2024
Subject : 3498 - Letter of Acceptance

To:
Mary Anne Grace Dorado & Charmaine Ramos Florece
Adventist University of the Philippines
Silang, Cavite, Philippines

Dear Respected Presenter(s),

We are pleased to inform you that your paper titled **"COMPETENCE and COMMITMENT of Barangay Health Workers: An Opportunity to bridge the community to a better Health Promotion Services"** (Code: 3498) has been accepted for presentation at the 11th International Scholars' Conference, which will be held on October 22–23, 2024, at Universitas Advent Indonesia (UNAI), Bandung, Indonesia.

Your presentation is scheduled as part of the conference program, and we invite you to prepare a **12-minute presentation**, followed by a 3-minute Q&A session. Please submit your **PowerPoint presentation** using the attached template by **October 10, 2024** to this link, with format name: PPT_Strand_PaperCode_Surname (Example: PPT_BusGov_3227_Siegian)

Additionally, we request you to kindly complete the link for registration form and the **consent form** for the inclusion of your paper in the conference proceedings. Both forms should be submitted by **September 30, 2024**.

Figure 8. The Result of the Generated Letter of Acceptance of 11ISC Conference Management System

3.1.4.Accommodation Assignment

The system includes a dedicated module for managing dormitory and room assignments (Figure 9). Admins can assign rooms based on participant preferences, ensuring better coordination and avoiding conflicts caused by manual tracking.

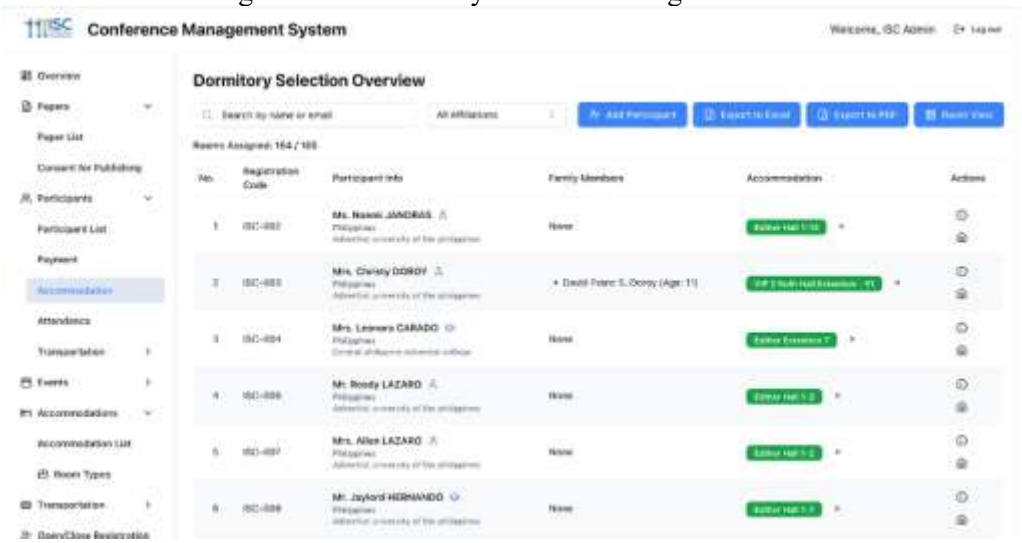

Figure 9.. Accommodation Assignment of 11ISC Conference Management System

3.1.5.Participant Card and QR Code Check-In

Once registered, each participant is issued a conference card with an embedded QR code (Figure 10). This card can be downloaded and printed. At check-in, admins use the QR scanner interface (Figure 11) to record attendance in real time.

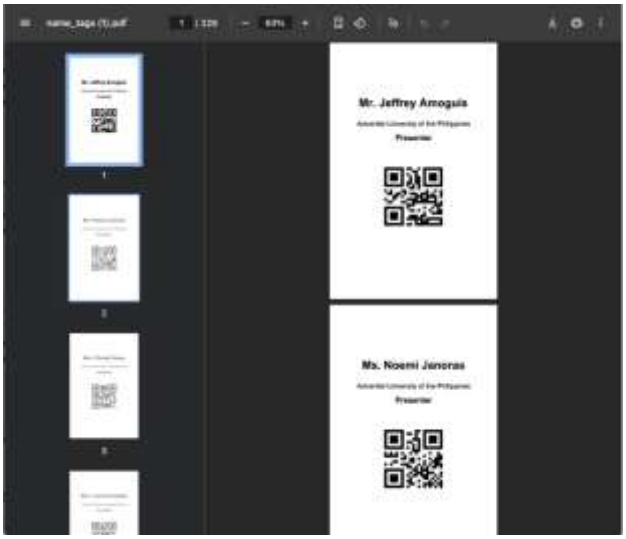

Figure 10. Generated Participant Card in the 11ISC Conference Management System

Figure 11. Database Diagram of 11ISC Conference Management System

3.1.6. Dashboard and Statistics

The dashboard (Figure 12) provides administrators with a real-time overview of key metrics, including registration counts, payment status, accommodation assignments, and arrival times. This aids in monitoring and managing the conference efficiently.

Figure 12. Dashboard view of 11ISC Conference Management System

3.1.8 .Event Management

Figure 13 presents the event attendees summaries for all events in the conference where the admin can see the attendance rate and also view the detailed attendees of the event if needed.

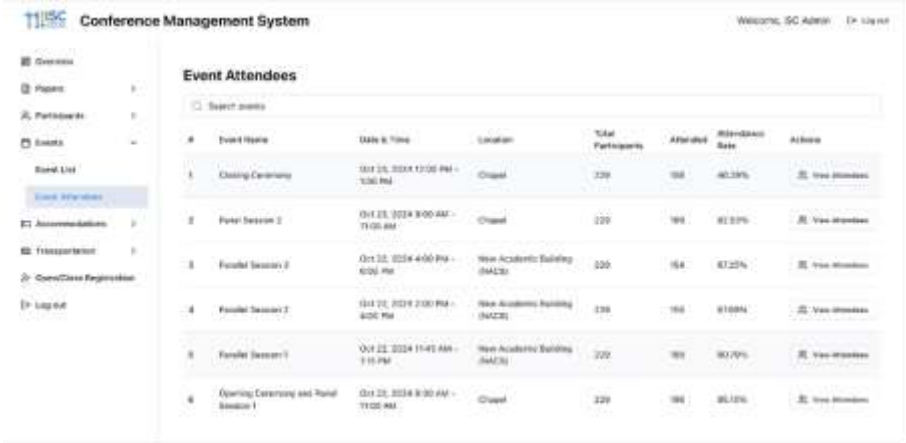

Figure 13. Event Attendees Page of 11ISC Conference Management System

3.2. Evaluation

To ensure the reliability and functional completeness of the 11ISC CMS, a series of structured system tests were conducted based on the primary use cases outlined in the system design. These tests covered both administrator and participant roles, focusing on core features such as registration, payment verification, document generation, QR-based check-in, and logistics coordination.

3.2.1. Black Box testing

Table 2 presents the results of the functional testing phase. Each use case was validated through scenario-based testing involving both administrator and participant roles, assessing the system's responses against expected outcomes. For instance, participant registration was verified to ensure proper data storage, confirmation email delivery, and QR code generation, while administrative functions—such as payment verification and LoA generation—were confirmed to update records and send PDF documents automatically.

Table 2. Functional Testing Results of the 11ISC Conference Management System

No.	Use Case	Actor	Test Scenario	Expected Result	Test Status
1	Register	Participant	Participant completes registration form and submits	Data saved successfully, confirmation email and QR code sent	Passed
2	Submit Payment Proof	Participant	Upload valid payment proof file	File accepted, status marked as pending verification	Passed
3	Verify Payment	Admin	Admin verifies uploaded proof	Payment status updated to "Verified"	Passed
4	Generate and Send LoA	Admin	Admin triggers LoA generation for verified participants	LoA PDF generated and emailed to participant	Passed
5	Generate Participant Card	Admin	Admin generates participant card	PDF participant card with QR code created	Passed
6	Check-in using QR Code	Participant	Participant scans QR code at registration desk	System marks participant as "Checked-In"	Passed
7	Assign Accommodation	Admin	Admin assigns participant to available room	Accommodation assigned, data saved successfully	Passed
8	Manage Affiliations	Admin	Add new university affiliation	Affiliation added and selectable in registration form	Passed

9	Import OJS Data	Admin	Admin uploads exported XML or CSV from OJS	Paper data imported and listed under paper management	Passed
10	View Dashboard	Admin	Admin logs in and views system metrics	Dashboard displays key statistics (e.g., registration count, paper status)	Passed
11	Manage Events	Admin	Admin adds and schedules events	Event created and appears on participant's view	Passed
12	Manage Attendances	Admin	Admin views attendance logs after check-in	List shows checked-in participants	Passed

3.2.2.Process Improvements Based on Stakeholder Feedback

Informal interviews and on-site observations with 11ISC administrators during the DSR evaluation phase revealed substantial improvements in administrative efficiency following the system's deployment. Table 3 outlines these key transformations. The most notable enhancement was the automation of LoA generation that previously was a manual, time-intensive task involving individual document editing and email distribution. The new module enabled instant, standardized LoA creation and delivery, greatly reducing workload and ensuring consistency.

Further gains were reported in room assignment, payment verification, and participant check-in. Manual tracking through spreadsheets and emails was replaced by integrated modules supporting real-time updates, automated documentation, and structured data entry. Administrators noted faster task completion, fewer errors, and smoother coordination across teams, affirming the system's effectiveness in addressing long-standing operational bottlenecks.

Table 3. Process Improvements Based on Administrator Feedback

No.	Task / Process	Previous Approach	Improved Approach via CMS	Reported Benefits (Interview Result)
1	Generating LoA	Manually drafted in Word and sent individually via email	Auto-generated PDF LoA, emailed with one click from the participant module	Time saved (up to 90%), consistency of format, reduced errors
2	Assigning Accommodation Rooms	Managed using separate Excel sheets and manual email coordination	Integrated room assignment interface with participant profiles	Faster room allocation, reduced double-booking, better coordination
3	Confirming Registration and Payment	Verified through email threads and manual bank transfer checks	Upload-based payment proof and admin verification dashboard	Centralized view, quicker verification, lower risk of oversight
4	Participant Check-in	Manual attendance list or paper checklist	QR code-based check-in system using participant card	Real-time check-in, accurate attendance log, lower queue congestion
5	Creating Participant Cards	Designed in Canva or Word manually for each participant	Automatically generated with participant data and QR code	Uniform layout, no design work needed, instantly available
6	Event and Schedule Management	Google Docs or email attachments	Centralized event management and visible schedule to participants	Better communication, minimized conflicting schedules
7	Affiliation Management	Manually entered, leading to inconsistencies and duplicates	Structured affiliation database with prefilled options	Clean data, consistent naming, efficient search

4. CONCLUSION

This paper has presented the design, development, and deployment of the 11ISC CMS, an integrated platform that streamlines participant registration, accommodation and transportation coordination, session scheduling, LoA generation, and QR-based attendance. Developed using the Design Science Research (DSR) methodology, the system addressed longstanding operational issues and was deployed during a conference involving over 180 paper submissions and more than 220 participants.

The results demonstrate clear efficiency gains, including a reduction of up to 90 percent in LoA preparation time and faster processing of accommodation assignments, payment verification, and participant check-in. These improvements reduced administrative workload, minimized errors, and enhanced coordination across organizing teams. The system shows strong potential for adoption in similar academic conferences, especially in resource-constrained settings.

4.1. Limitation

Several limitations should be noted. The evaluation relied on functional testing and feedback from a small group of administrators, and no formal load testing or performance assessment under high concurrency was conducted. The system was deployed for a small-scale event, so scalability for larger conferences remains unverified. In addition, integration with external services such as payment gateways and institutional authentication was not implemented, and interaction with Open Journal Systems (OJS) is limited to data import rather than real-time API-based integration.

Future development may include integrating secure online payment gateways, enabling OJS API connectivity to streamline data flow between review and logistics stages, and developing a mobile application to enhance participant engagement. Formal performance benchmarking and scalability testing will also be important for preparing the system for larger and more complex conference settings.

REFERENCES

[1] A. Merianos, M. Smith, and H. Goltz, “Developing Professional Identity and Networks at Conferences,” *Health Behav. Res.*, vol. 5, no. 3, Aug. 2022, doi: 10.4148/2572-1836.1170.

[2] D. Avison, K. Kautz, M. Sigala, E. A. Whitley, and R. Winter, “Becoming Engaged with Conferences: Reputations and Networks,” Commun. Assoc. Inf. Syst., vol. 16, no. 1, Dec. 2005, doi: 10.17705/1CAIS.01646.

[3] A. Oruc, “Tools for Organizing an Effective Virtual Academic Conference,” Ser. Rev., vol. 47, no. 3–4, pp. 231–242, Oct. 2021, doi: 10.1080/00987913.2022.2050615.

[4] “EasyChair.” Accessed: Jun. 22, 2025. [Online]. Available: https://easychair.org/overview

[5] OpenConf, “OpenConf Peer-Review, Conference and Abstract Management Software System.” Accessed: Jun. 22, 2025. [Online]. Available: https://www.OpenConf.com/

[6] “HotCRP.com.” Accessed: Jun. 22, 2025. [Online]. Available: https://hotcrp.com/

[7] “Conference Management.” Accessed: Jun. 22, 2025. [Online]. Available: https://easychair.org/conference_management

[8] W. H. W. Ishak, F. M. Yamin, M. F. M. Mohsin, and M. F. Mansor, “A COMPARATIVE REVIEW OF CONFERENCE MANAGEMENT SYSTEM,” J. Technol. Oper. Manag., vol. 18, no. 2, Art. no. 2, Dec. 2023, doi: 10.32890/jtom2023.18.2.7.

[9] “ConfTool - Flexible Conference and Event Management Software.” Accessed: Jun. 22, 2025. [Online]. Available: https://www.conftool.net/en/index.html

[10] “Your Scholarly Events Partner | Ex Ordo.” Accessed: Jun. 22, 2025. [Online]. Available: https://www.exordo.com

[11] B. Yang, H. Liu, X. Xiong, S. Zhu, A. Tolba, and X. Zhang, “A Big Data Platform for International Academic Conferences Based on Microservice Framework,” Electronics, vol. 12, no. 5, Art. no. 5, Jan. 2023, doi: 10.3390/electronics12051182.

[12] R. Rotikan, "OPSS: Online Paper Submission System Untuk Kegiatan Konferensi Ilmiah," CogITo Smart J., vol. 2, no. 2, Art. no. 2, Dec. 2016, doi: 10.31154/cogito.v2i2.32.229-239.

[13] M. Lu, K. Zhao, and B. C. Desai, "ConfSys: a kaizen conference management system," in Proceedings of the International Conference on Computer Science and Software Engineering, in C3S2E '13. New York, NY, USA: Association for Computing Machinery, Jul. 2013, pp. 5–13. doi: 10.1145/2494444.2494488.

[14] I. M. Yassin, Y. M. Yusof, A. Johari, A. Zabidi, and H. A. Hassan, "CRS: Registration extension of the OpenConfTM Conference Management System," in 2011 IEEE International Conference on Computer Applications and Industrial Electronics (ICCAIE), Dec. 2011, pp. 591–596. doi: 10.1109/ICCAIE.2011.6162203.

[15] J. Willinsky, "Open Journal Systems," Libr. Hi Tech, vol. 23, no. 4, pp. 504–519, Jan. 2005, doi: 10.1108/07378830510636300.

[16] A. Popescu, P. Lammich, and P. Hou, "CoCon: A Conference Management System with Formally Verified Document Confidentiality," J. Autom. Reason., vol. 65, no. 2, pp. 321–356, Feb. 2021, doi: 10.1007/s10817-020-09566-9.

[17] V. K. Vaishnavi and W. Kuechler, Design Science Research Methods and Patterns. Boca Raton: CRC Press, 2015.

[18] A. Hevner and S. Chatterjee, Design Research in Information Systems: Theory and Practice, vol. 22. in Integrated Series in Information Systems, vol. 22. Boston, MA: Springer US, 2010. doi: 10.1007/978-1-4419-5653-8.

[19] S. Gregor and A. R. Hevner, "Positioning and presenting design science research for maximum impact," MIS Q, vol. 37, no. 2, pp. 337–356, Jun. 2013, doi: 10.25300/MISQ/2013/37.2.01.

[20] A. Nuhi, A. Memeti, F. Imeri, and B. Cico, "Smart Attendance System using QR Code," in 2020 9th Mediterranean Conference on Embedded Computing (MECO), Jun. 2020, pp. 1–4. doi: 10.1109/MECO49872.2020.9134225.

[21] A. D. Yusuf, M. M. Boukar, and S. Shamiluulu, "Automated batch certificate generation and verification system," in 2017 13th International Conference on Electronics, Computer and Computation (ICECCO), Nov. 2017, pp. 1–5. doi: 10.1109/ICECCO.2017.8333321.

[22] S. Srivastava, H. Shukla, N. Landge, A. Srivastava, and D. Jindal, "A Comprehensive Review of Next.js Technology: Advancements, Features, and Applications," May 16, 2024, Social Science Research Network, Rochester, NY: 4831070. doi: 10.2139/ssrn.4831070.

[23] C. Lee and S. Jeon, "A Study on the Security Performance of JWT Token Signature Algorithms," Converg. Secur. J., vol. 24, no. 4, pp. 3–10, 2024, doi: 10.33778/kcsa.2024.24.4.003.

[24] M. Riva, Real-World Next.js: Build scalable, high-performance, and modern web applications using Next.js, the React framework for production. Birmingham: Packt Publishing, 2022.

[25] R. Archer, Express.js: Web App Development with Node.js Framework. North Charleston, SC, USA: CreateSpace Independent Publishing Platform, 2016.

[26] W. Reese, "Nginx: the high-performance web server and reverse proxy," Linux J, vol. 2008, no. 173, p. 2:2, Sep. 2008.