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Design and Implementation of a Co-Curricular Management System with Genetic Algorithm–Based Venue Optimization at Nilai University, Malaysia

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ARTICLE INFO	ABSTRACT
   	Nilai University has more than 20 active clubs and societies that organize various co-curricular activities. However, the approval process for event proposals and the submission of post-event reports are handled manually, which often results in delays, loss of documents, and unnecessary workload for students, advisors, and coordinators. These challenges highlight the need to streamline and digitize existing processes to improve efficiency and transparency. This study presents the development of a CoCurricular Management System (CCMS) designed to digitize event management processes and centralize information related to proposals, event scheduling, committee structures, event flow planning, and postevent documentation within a MySQL database. In addition, a Genetic Algorithm (GA) is integrated to optimize venue allocation based on event type, estimated attendance, and indoor or outdoor requirements. The platform features user-friendly interfaces that enable students, club advisors, and coordinators to manage event-related tasks online from any location. System performance was evaluated through a human expert accuracy test, which recorded 65% similarity between human-selected venues and GA recommendations. A 30-run stability test demonstrated reliable convergence with an average success rate of 97%, and low variation measured using Coefficient of Variation (CV = 0.00–0.056, mean 0.015). Usability testing conducted through a workshop survey indicated that the system is effective, efficient, and easy to use. In conclusion, the CCMS provides a more reliable and efficient solution for managing cocurricular activities at Nilai University by enhancing productivity, reducing administrative burden, and supporting optimized venue selection through algorithmic decision-making, evaluated using a single-institution case study.

1. Introduction

Co-curricular activities constitute an essential component of university education, as they contribute to the development of students' soft skills, leadership abilities, and teamwork beyond the formal academic curriculum. Universities regularly organise a wide range of co-curricular

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programmes, including workshops, tournaments, sports events, and community engagement activities. As the number of such activities increases, managing event proposals, committee structures, financial records, and post-event reports becomes increasingly challenging, particularly when the processes involved are poorly organised [1,2,9].

At many higher education institutions, the management of co-curricular events is still conducted manually or with minimal technological support, such as paper-based forms and basic online tools. This approach often results in prolonged approval processes, loss of important documents, and increased administrative workload for students, advisors, and organisers. Venue selection is another common challenge, as it is frequently based on subjective judgement rather than a systematic evaluation process. Consequently, unsuitable venues may be selected, leading to space constraints or inefficient utilisation of available resources [3,8].

To improve record-keeping and operational efficiency, several digital systems for event and co-curricular management have been developed. These systems assist in organising event-related information, storing documents, and facilitating communication among stakeholders [4]. However, most existing solutions primarily focus on data management and user interface functionality. They generally lack intelligent decision-support mechanisms, particularly for venue selection, which in many cases continues to rely on manual decision-making.

Venue selection for co-curricular events is a complex task that involves multiple factors, including event type, expected attendance, and venue suitability. Optimisation techniques such as Genetic Algorithms (GA) have been widely applied in academic scheduling, course timetabling to address similarly complex problems [6,7]. GA is well suited for problems characterised by numerous constraints and large solution spaces. Previous studies have demonstrated that GA-based approaches can enhance efficiency and reduce conflicts compared to traditional manual methods. Nevertheless, most GA-related research has focused on academic scheduling applications rather than co-curricular event management.

Based on the existing literature, a clear research gap can be identified. Although digital cocurricular management systems are available, they rarely incorporate optimisation techniques to support decision-making processes. At the same time, while GA has been successfully applied in scheduling and allocation contexts, its application to co-curricular event venue selection remains limited [11]. This highlights the need for an integrated system that combines co-curricular management with intelligent venue optimisation.

Therefore, this study aims to design and implement a Co-Curricular Management System (CCMS) enhanced with a Genetic Algorithm for venue optimisation. The proposed system supports the complete co-curricular event workflow and provides automated venue recommendations based on event characteristics and predefined constraints. The system is implemented and evaluated using real co-curricular event data from Nilai University as a case study, and its performance is systematically assessed.

This study adopts Nilai University as a case study to demonstrate the design, implementation, and evaluation of a co-curricular management system integrated with GA-based venue optimisation. While the system is evaluated using real institutional data from a single university, the proposed architecture and optimisation framework are designed to be adaptable to other higher education institutions with similar co-curricular structures and approval workflows. Therefore, the findings of this study provide insights into the applicability of intelligent decision-support systems for cocurricular management beyond the immediate study context.

2. Methodology

2.1 System Overview

The proposed Co-Curricular Management System (CCMS) is a web-based application developed to support the management of co-curricular events at Nilai University. The system is designed to facilitate collaboration among students, advisors, and coordinators throughout the entire event management lifecycle. It provides structured access to essential event-related information, including proposal details, committee structures, budget records, meeting minutes, and post-event documentation.

The CCMS incorporates a Genetic Algorithm (GA) as a decision-support mechanism for venue selection. The GA evaluates key event parameters, such as event category (indoor or outdoor), estimated number of participants, and venue availability, to recommend a suitable venue during the proposal submission stage. By integrating workflow automation and intelligent venue optimisation, the CCMS aims to enhance efficiency, transparency, and consistency in the management of cocurricular activities at Nilai University.
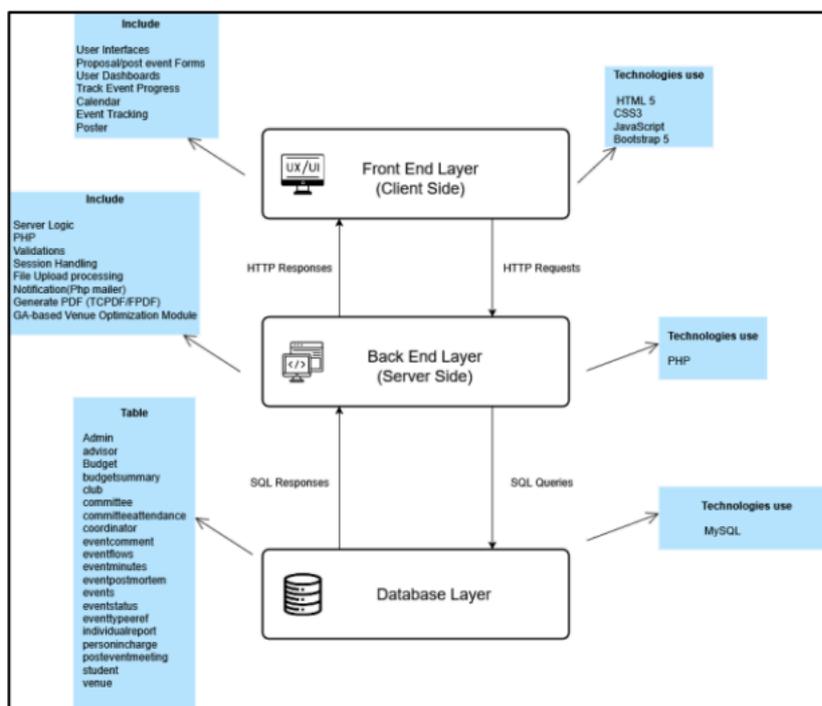
2.2 System Architecture

As illustrated in Figure 1, the proposed Co-Curricular Management System (CCMS) adopts a three-tier architecture comprising the front-end layer, back-end layer, and database layer. This layered architecture separates user interaction, application logic, and data management, thereby improving system maintainability, scalability, and extensibility.

The front-end layer provides user interfaces for students, advisors, and coordinators, enabling them to perform tasks such as submitting event proposals, uploading post-event reports, tracking event progress, and viewing dashboards. User requests are transmitted to the server through HTTP communication.

The back-end layer is responsible for executing the core application logic, including input validation, session management, file processing, notification handling, and document generation. This layer also integrates the Genetic Algorithm–based venue optimisation module, which generates venue recommendations based on event type, estimated participant count, and venue availability. The processed results are subsequently returned to the client interface.

The database layer stores all system-related data, including user records, event information, budget details, committee data, venue information, event schedules, and post-event reports. Data exchange between the back-end and the database is managed through structured SQL queries to ensure consistency, integrity, and efficient data processing.

Fig. 1. Architecture of the proposed co-curricular management system

2.3 System Flow of the CCMS

The operation of the proposed Co-Curricular Management System (CCMS) begins with the formation of an event committee by students. One committee member, typically the secretary or chairperson, is assigned the responsibility of submitting the event proposal. The designated student logs into the system and initiates the proposal by entering event details, selecting the organising club, assigning the person in charge, recording meeting minutes, listing committee members eligible for Co-Curricular (CoCU) claims, preparing the event budget, and selecting a potential event venue.

During the proposal submission stage, the Genetic Algorithm (GA) automatically generates a venue recommendation. This recommendation is based on key event parameters, including the event category (indoor or outdoor), estimated number of participants, and venue availability. Once the proposal is submitted, it is forwarded to the club advisor for review. If the advisor approves the proposal, it is then escalated to the coordinator for final evaluation. In cases where the proposal is rejected, it is returned to the student for revision and resubmission.

The coordinator follows a similar review process. Approval at this stage allows the event to proceed, whereas rejection results in the proposal being sent back to the student for further revision. Upon completion of the event, the secretary or chairperson submits a post-event report through the system. This report includes the event flow, meeting records, committee attendance, financial statements, event photographs, and individual reports for committee members applying for CoCU points.

The submitted post-event report is reviewed by the coordinator. If the report is approved, the system generates a reference number to support CoCU point claims for eligible committee members. If the report is rejected, it is returned to the student for correction and resubmission.

2.4 Genetic Algorithm Design

A Genetic Algorithm (GA) is employed in the proposed CCMS to identify the most suitable venue for co-curricular events. Venue selection represents a constrained optimisation problem that requires simultaneous consideration of multiple factors. GA has been widely applied in allocation and scheduling problems characterised by large search spaces and multiple constraints, making it suitable for this context [6,7].

Several optimisation and decision-support approaches have been applied to allocation and venue selection problems, including rule-based methods, multi-criteria decision-making techniques such as SMART, and metaheuristic algorithms such as Ant Colony Optimisation (ACO) [11,15]. Rule-based approaches rely on predefined conditions and lack flexibility when constraints or event characteristics change, while multi-criteria decision models require explicit weighting of criteria, which may introduce subjectivity and reduce adaptability. Metaheuristic techniques such as ACO have shown promising results in spatial and venue-related optimisation however, they are often tailored to specific problem formulations and require additional parameter tuning [11].

In comparison, GA offers greater flexibility in handling multi-constraint optimisation, large solution spaces, and dynamic fitness evaluation without requiring extensive historical data. Its successful application in academic scheduling and resource allocation problems with similar characteristics further supports its suitability for co-curricular event venue optimisation within the proposed CCMS [6,7,13,14].

2.4.1 Problem representation

Each candidate solution, referred to as a chromosome, represents a possible venue that can be assigned to an event. The chromosome encodes key venue attributes, including maximum capacity, supported event types (indoor or outdoor), and availability based on the proposed event date and time. The input parameters for the Genetic Algorithm are derived from the event proposal submitted by students. These parameters include the estimated number of participants and relevant event details, which are used to evaluate the suitability of each venue during the optimisation process.

2.4.2 Fitness function

The fitness function evaluates each candidate venue by assessing the most critical constraints. The primary criteria considered include the venue's capacity to accommodate the expected number of participants, its availability on the specified event date and time, and its suitability for the event type. Venues that fail to satisfy essential constraints, such as being unavailable or incompatible with the event category, are assigned lower fitness values. A higher fitness score indicates a more suitable venue for the proposed event.

2.4.3 Genetic operators

The initial population is generated by randomly selecting venues from the venue database. The selection process favours candidate venues with higher fitness values, allowing more suitable solutions to propagate to subsequent generations. Crossover and mutation operators are applied to introduce diversity within the population and to prevent premature convergence, thereby enabling the Genetic Algorithm to explore alternative venue combinations effectively [6].

2.4.4 Termination and output

The Genetic Algorithm terminates when a predefined number of generations is reached or when no further improvement in fitness values is observed. Upon termination, the venue with the highest fitness score is selected as the final solution. The algorithm generates a single optimal venue recommendation, which is automatically returned to the system and displayed to students during the event proposal process.

2.5 Venue Optimization Process

Within the CCMS, the venue optimisation process is initiated during the creation of an event proposal. When a student begins the proposal submission, relevant event information is collected, including the event type (indoor or outdoor), estimated number of participants, and the proposed event date and time. Based on these inputs, the system retrieves a list of venues from the database that satisfy the basic availability constraints.

The collected parameters are then forwarded to the GA-based venue optimisation module, where the fitness function described in Section 2.4 is applied to evaluate potential venues. Venues that fail to meet essential constraints, such as availability or event type compatibility, are penalised, while eligible venues are scored according to their overall suitability and degree of fit. The Genetic Algorithm iteratively evaluates candidate solutions and progressively converges towards the optimal venue.

Upon completion of the optimisation process, the GA outputs a single venue recommendation with the highest fitness score. This recommended venue is automatically populated in the proposal form, allowing students to proceed with submission without manually selecting a venue. This integrated approach ensures that venue allocation is optimised, consistent, and aligned with event requirements, while reducing reliance on manual decision-making [12].

2.6 Evaluation Methods

The proposed CCMS and its GA-based venue optimisation were evaluated using three complementary methods to assess accuracy, reliability, and usability. These evaluation approaches were designed to validate the effectiveness of the venue recommendation mechanism as well as the overall performance of the system.

2.6.1 Expert match accuracy test

The expert match accuracy test was conducted to evaluate the similarity between the venue recommended by the Genetic Algorithm and the venue selected by a human expert. In this study, the human expert refers to the club advisor who had previously reviewed and approved co-curricular event proposals. A set of event cases was provided to the system, and the venue recommendations generated by the Genetic Algorithm were compared with the venues chosen by the advisor. A match between the two selections was considered a correct outcome. The accuracy rate was calculated using Eq. (1).

$$Accuracy(\%) = \frac{Nmatch}{Ntotal} x\ 100 \qquad (1)$$

Nmatch= number of cases where GA venue matches advisor decision
Ntotal= total number of evaluated event cases

2.6.2 Stability test

A stability test was conducted to evaluate the consistency of the Genetic Algorithm (GA) in venue recommendation. For a fixed event configuration, the GA was executed 30 times using identical input parameters. The selected venue and the corresponding fitness value were recorded for each execution. To quantify the variation in the results, the mean fitness value, standard deviation, and coefficient of variation (CV) were calculated. The mean fitness value was computed using Eq. (2), the standard deviation was calculated using Eq. (3), and the coefficient of variation was calculated using Eq. (4). A lower CV value indicates higher stability and more consistent convergence behaviour of the Genetic Algorithm.

$$\bar{x} = \left(\frac{1}{n}\right) \sum_{i=1}^{n} x_i \qquad (2)$$

$$\sigma = \sqrt{\left(\frac{1}{n}\right) \sum_{i=1}^{n} (x_i - \bar{x})^2} \qquad (3)$$

$$CV = \frac{\sigma}{\bar{x}} \qquad (4)$$

Usability test A questionnaire-based survey was conducted to evaluate the usability of the CCMS during a workshop session. The participants consisted of students and advisors who used the system throughout the workshop. The questionnaire employed a Likert-scale format to assess the system in terms of ease of use, effectiveness, and efficiency. The collected responses were analysed to determine user satisfaction and the overall acceptance of the system [10].

3. Results
3.1 Expert match accuracy results

Based on the evaluation results presented in Table 1, the Genetic Algorithm (GA) generated matching venue recommendations for 13 out of 20 test cases, while 7 cases resulted in different venue selections. Using Eq. (1), the expert match accuracy was calculated to be 65%. This result indicates that the GA-based venue optimisation approach is generally consistent with expert judgement.

Similar expert-based evaluation methods have been applied in previous studies on academic and event management decision-support systems [3]. The observed accuracy demonstrates that the GA is capable of producing venue recommendations that largely align with expert decisions. Instances of mismatch are primarily attributed to contextual factors or subjective preferences, such as an advisor's personal judgement or the presence of multiple equally suitable venues. These aspects are not explicitly captured within the fitness function. Nevertheless, the results indicate that the GA

serves as an effective decision-support tool for venue selection within the CCMS. An expert–algorithm match accuracy of 65% represents a moderate level of agreement rather than perfect consistency. Given the inherently subjective nature of venue selection and the presence of contextual considerations that may influence expert decisions, discrepancies between GA recommendations and expert selections do not necessarily indicate incorrect outcomes. In some cases, multiple venues may satisfy the defined constraints equally well, while experts may prioritise qualitative factors that are not explicitly modelled in the fitness function. Therefore, the reported accuracy supports the use of the GA-based approach as a decision-support mechanism that assists, rather than replaces, human judgement in venue selection.

Table 1
Summary of expert match accuracy results

Item	Value
Total Test Cases	20
Matching Cases	13
Non-Matching Cases	7
Expert Match Accuracy	65%

3.2 Stability Test Result

A 30-run stability test was conducted to evaluate the consistency and reliability of the GAbased venue optimisation, as described in Section 2.6.2. For each selected event configuration, the Genetic Algorithm was executed 30 times using identical input parameters, and the selected venue along with the corresponding fitness value was recorded for each run [6,13].

Table 2 summarises the stability test results. For most test cases, the GA consistently selected the same venue across all 30 runs, indicating stable convergence behaviour [14]. The mean fitness value, standard deviation, and coefficient of variation (CV) were computed using Eq. (2), Eq. (3), and Eq. (4), respectively.

To illustrate the calculation process, for an indoor event with 40 participants, the GA selected "Classroom T104" in 28 out of 30 runs. The success percentage was therefore calculated as (28/30) × 100% = 93.33%. The average fitness value was obtained by averaging the fitness values across all 30 executions using Eq. (2). As the fitness values remained constant for the dominant venue, both the standard deviation and CV were equal to 0.00, indicating highly stable GA behaviour.

Overall, the CV values ranged from 0.00 to 0.056, with a mean CV of 0.015. These low CV values indicate minimal variation relative to the mean fitness values, confirming that the GA produces consistent and repeatable results despite its stochastic nature. This demonstrates that the GA-based venue optimisation approach is stable and suitable for repeated use within the CCMS. Table 2 - Summary of Stability Test Results (30 Runs) Metric Value Number of Runs 30 Mode Selected Value Same Venue across all runs Average fitness value 120.00 Standard Deviation 0.00 – 6.72 Coefficient of variation (CV) 0.00 – 0.056 Mean CV 0.015

3.3 Usability Evaluation Result

A questionnaire-based survey conducted during a CCMS workshop session was used to evaluate the usability of the proposed system. A total of 32 participants, comprising students and advisors, took part in the usability study after interacting with the system. The questionnaire employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to capture participants' perceptions of the system [10]. The usability evaluation focused on three primary dimensions: ease

of use, effectiveness, and efficiency. A summary of the results is presented in Table 3. Overall, the findings indicate a high level of user satisfaction across all usability dimensions. Participants reported that the system was easy to use and that assigned tasks could be completed with minimal difficulty. In addition, users indicated that the system effectively supported the management of event proposals and venue selection. Most participants were able to complete the required tasks without external assistance, demonstrating that the CCMS is both effective and user-friendly. These results suggest that the system is suitable for practical implementation and can be readily adopted by students and advisors at Nilai University for managing co-curricular activities.

Table 3
Summary of usability evaluation results

Usability Dimension	Mean Score
Ease of use	4.4
Effectiveness	4.5
Efficiency	4.3

3.4 Discussion

The results demonstrate that the proposed CCMS is capable of effectively managing cocurricular events at Nilai University through the integration of workflow automation and GA-based venue optimisation. An expert match accuracy of 65% indicates that the GA is able to generate venue recommendations that are largely consistent with expert decisions. This suggests that the system is best utilised as a decision-support tool rather than a replacement for human judgement [15]. Similar expert-in-the-loop validation approaches have been adopted in previous studies on academic and event management systems to enhance decision reliability [3]. It should also be noted that the reported expert–algorithm match accuracy was not benchmarked against alternative optimisation or rule-based approaches, which is acknowledged as a limitation of the current evaluation.

The stability test further confirms the robustness of the GA-based venue selection mechanism. The consistent results obtained across 30 executions, together with the low Coefficient of Variation (CV) values, indicate that the algorithm is not highly sensitive to random initialisation. This behaviour is consistent with findings reported in prior GA-based scheduling, where repeated executions produce stable and reliable outcomes [6]. Such stability is a critical requirement for practical deployment in real-world educational environments.

In terms of usability, participants in the CCMS workshop reported high levels of satisfaction, indicating that the system is easy to use, effective, and efficient. These findings suggest that students, advisors, and coordinators can adopt the system with minimal training due to its user-friendly interface. Overall, the results indicate that the proposed CCMS enhances administrative efficiency, reduces manual workload, and supports data-driven venue selection [5]. Future enhancements may include incorporating additional constraints and refining the optimisation model to enable the recommendation of multiple suitable venues, thereby further improving system flexibility and decision quality. Although the proposed GA-based approach demonstrates promising performance, future studies may compare it with rule-based or heuristic baseline methods to further quantify performance improvements in venue selection.

4. Conclusions

This study presented the design, development, and implementation of a web-based CoCurricular Management System (CCMS) for Nilai University that integrates a Genetic Algorithm (GA) for venue

optimisation. The proposed system digitises the complete co-curricular event management workflow, including proposal submission, multi-level approval processes, automated venue recommendations, and post-event reporting. By embedding GA as a decision-support component, the CCMS demonstrates how intelligent optimisation techniques can be applied to improve efficiency and consistency in co-curricular management processes.

The performance of the system was evaluated through an expert match accuracy test, a 30-run stability test, and a usability evaluation. The expert match accuracy of 65% indicates a moderate level of agreement between GA recommendations and expert selections, supporting the role of the GA as a decision-support mechanism rather than a replacement for human judgement. The stability test results confirmed consistent algorithm behaviour across repeated executions, with low Coefficient of Variation (CV) values, indicating reliable convergence. In addition, usability evaluation findings revealed high user satisfaction, suggesting that the system can be effectively adopted by students, advisors, and coordinators with minimal training.

Despite these positive outcomes, several limitations of the study should be acknowledged. The system was implemented and evaluated using data from a single institution, which may limit the generalisability of the findings to universities with different co-curricular structures or administrative policies. The expert match accuracy evaluation was conducted using a limited number of event cases and relied on subjective expert judgement, while the usability assessment reflected short-term perceptions gathered during a workshop session. Furthermore, the performance of the GA-based venue optimisation was not benchmarked against alternative optimisation or rule-based approaches, which restricts direct comparison of relative effectiveness.

From a deployment perspective, scalability and system maintenance remain important considerations. As the number of events, venues, and users increases, database growth and GA runtime may introduce additional computational overhead. Integration with existing institutional systems, such as student information systems or learning management platforms, would also be necessary to support large-scale adoption. Addressing these challenges is essential to ensure longterm system sustainability beyond the initial implementation context.

Overall, the proposed CCMS demonstrates the practical potential of combining workflow automation with GA-based venue optimisation to enhance administrative efficiency and support data-driven decision-making in co-curricular event management. While the current implementation provides a functional and reliable foundation, further refinement and evaluation are required to strengthen robustness, scalability, and broader applicability.

Future work will focus on addressing the identified limitations and enhancing system performance. First, the GA fitness function can be further refined by incorporating additional qualitative and contextual criteria to improve expert–algorithm agreement beyond the current 65% accuracy. Second, comparative benchmarking against alternative optimisation and decision-support approaches, such as rule-based methods, Ant Colony Optimisation (ACO), Particle Swarm Optimisation (PSO), and hybrid techniques, should be conducted to evaluate relative solution quality, convergence behaviour, and computational efficiency. Finally, large-scale deployment studies involving a greater number of events, venues, and users, as well as integration with existing institutional systems, would provide deeper insights into scalability, maintenance requirements, and long-term applicability of the CCMS.

References

[1]   Nur Amirah, and Mohd Azhar. 2020. "Development of School Co-Curricular Management Application." January 2, 2020. https://www.researchgate.net/publication/338343095_Development_of_School_CoCurricular_Management_Application.

[2]   Perilla, Fernandino S., and Alvin R. Malicdem. "Design architecture of a student co-curricular activity management platform." *International Journal of Recent Technology and Engineering* 8, no. 2 (2019): 2753-2757. https://doi.org/10.35940/ijrte.B1338.0982S1119

[3]   Azmi, Putera Al-Amin Shah Ulul, and Noraini Ibrahim. "UTHM Students' Event Management System." *Applied Information Technology And Computer Science* 2, no. 2 (2021): 697-716.

[4]   Shah, Drahsti Amrish, Hemalata Vasudavan, and Nurul Farhaini Razali. "Event Management Systems (EMS)." *Journal of Applied Technology and Innovation* 7, no. 2 (2023): 45-53.

[5]   Halim, Abdul Hamid Abdul, Norol Hamiza Zamzuri, and Ayu Rohaidah Ghazali. "The transformative role of artificial intelligence in the event management industry." *Journal of International Business, Economics and Entrepreneurship* 8, no. 2 (2023): 98-106. https://doi.org/10.24191/jibe.v8i2.24045

[6]   Ying, Lim Ying, and Hazinah Kutty Mammi. "Timetable Scheduling System using Genetic Algorithm (tsuGA)." [7] Paramatmuni, Sahith Siddharth, Dumpala Yashwanth Reddy, Elakurthi Sai Spoorthi, Akhil Dharani, and K. Venkatesh Sharma. "Smart Timetable Generation using Genetic Algorithm." *Macaw International Journal of Advanced Research in Computer Science and Engineering* 10, no. 1s (2024): 204-215.

[8]   Goyal, Deepanshu, Arbab Ali, and Md Nafis Haider. "Project report and research on online event management system." *Turkish Journal of Computer and Mathematics Education* 12, no. 6 (2021): 5297-5303. [9]Veeraiah, Premaselvi, and Simin Ghavifekr. "Management Strategies for Co-Curricular Activities among Primary School Students in Teluk Intan." *International Journal of Advanced Research in Education and Society* 4, no. 1 (2022): 41-52.

[10]   Anuar, Nurhilyana, Raudzatul F. Mohd Said, Teh FA Rahman, Aminatul S. Idris, and Zamri Abu Bakar. "Empirical Study on Acceptance of Co-Curriculum Registration System (CoRS) Among Students in Center of Foundation Studies, UiTM." *Journal of Economic & Management Perspectives* 12, no. 1 (2018): 413-419.

[11]   Zhang, Rui, Weibo Sun, and Sang-Bing Tsai. "Simulation of sports venue based on ant colony algorithm and artificial intelligence." *Wireless Communications and Mobile Computing* 2021, no. 1 (2021): 5729881.https://doi.org/10.1155/2021/5729881

[12]   Xiong, Dongxu, Chenxi Shao, and Rui Zhang. "The Evaluation of Spatial Allocation and Sustainable Optimization Strategies for Sports Venues in Urban Planning Based on Multi-Source Data: A Case Study of Xi'an." *Buildings* 15, no. 8 (2025): 1354. https://doi.org/10.3390/buildings15081354

[13]   Abduljabbar, Israa Abdulameer, and Sura Mahmood Abdullah. "An evolutionary algorithm for solving academic courses timetable scheduling problem." *Baghdad Science Journal* 19, no. 2 (2022): 11.https://doi.org/10.21123/bsj.2022.19.2.0399

[14]   Zhang, Qiang. "An optimized solution to the course scheduling problem in universities under an improved genetic algorithm." *Journal of Intelligent Systems* 31, no. 1 (2022): 1065-1073.. https://doi.org/10.1515/jisys-2022-0114

[15]   Abdullah, Siti Sarah, and Finni Rizkia. "Model of decision support method with SMART according to choosing venue." In *Journal of Physics: Conference Series*, vol. 1764, no. 1, p. 012064. IOP Publishing, 2021.. https://doi.org/10.1088/1742-6596/1764/1/012064