

SmartCWE: An Intelligent Management System for Cooperative Education in the Digital Age

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ABSTRACT

Thaksin University's Bachelor of Science in Computer Science program has transitioned to a cooperative education (co-op) model to better prepare students for the digital industry. However, challenges emerged, such as delays in placements, mismatches between student skills and placements, and difficulties in monitoring performance. This research introduces SmartCWE, an intelligent system designed to streamline the co-op process using digital technologies. SmartCWE improves the matching of students to suitable internships, enhances communication between students, institutions, and employers, and provides real-time tracking and feedback tools. The system was developed using an Agile methodology, involving iterative development and continuous feedback from students and faculty. The research followed four key stages: system design, implementation, evaluation through surveys, and refinement. Initial results show that SmartCWE has reduced administrative burdens and improved the co-op experience for both students and instructors. Future updates will include a recommendation system to better prepare students for their internships, supporting their career development in the digital industry.

Keywords: Cooperative Education, CWIE, Intelligent Management System, Internship Management System.

1 INTRODUCTION

For over two decades, the Computer Science program at Thaksin University has been dedicated to preparing graduates to meet the evolving demands of the digital industry. This program blends theoretical knowledge with practical application, offering students valuable workplace experiences through internships with both private companies and government organizations. Originally structured as a two-month summer placement during the third year, the program transitioned to a cooperative education (co-op) model in 2020, extending the duration of workplace training to four months. This transition enables students to acquire more in-depth professional experience, providing them with the skills and insights necessary for making well-informed career decisions. Additionally, it increases their potential for securing employment opportunities after graduation.

The cooperative education process can be divided into three distinct phases: the pre-cooperative phase, the during-cooperative phase, and the post-cooperative phase [1]. During the pre-cooperative

phase, students select organizations for training, which can be challenging due to the absence of a comprehensive database for suitable placements. This often results in lengthy selection processes and mismatched placements. Moreover, monitoring and documenting student progress throughout the cooperative and post-cooperative phases remains a persistent challenge.

Research from [2, 3, 4, 5] indicate that structured cooperative education programs play a crucial role in boosting employability by providing students with valuable industry experience, fostering workplace self-development, and smoothing the transition into full-time employment. By leveraging digital technologies, SmartCWE enables seamless communication and collaboration among students, faculty, and organizations through messaging platforms and document management systems. This real-time interaction facilitates efficient coordination and feedback, ultimately enhancing the overall co-op experience.

Several universities, including Suranaree University, Sripatum University, Walailuk University, and Thonburi University, have developed systems to manage cooperative education programs, emphasizing the crucial role of digital platforms in overseeing student internships. SmartCWE builds on these efforts by offering essential functionalities such as documentation management and progress tracking. Furthermore, with its integrated skill-matching feature and evaluation tools, SmartCWE enhances student employability by aligning their training experiences more effectively with industry demands.

This paper is structured to provide an overview of related literature, followed by the development process of SmartCWE, an analysis of the results, and a discussion on how cooperative education impacts employability and the continuous improvement of the system.

2 LITERATURE REVIEW

This section begins by detailing the management system of the cooperative education program in the Computer Science department at Thaksin University. The following part explains the application of agile methodology in developing the cooperative education program.

2.1 Cooperative Education Management System

Cooperative education, or co-op, is a structured educational program that integrates classroom learning with practical work experience. In this program, students are required to work as full-time employees in their field of study for at least 16 consecutive weeks, emphasizing work-based learning. In Thailand, Suranaree University of Technology (SUT) introduced cooperative education in 1993, with the first cohort of students engaging in workplace-based cooperative education during the 1995 academic year. The Computer Science program has actively encouraged students to engage in internships to gain practical experience before graduation and has fully integrated cooperative education into its curriculum since 2020. This implementation is overseen by the Academic Affairs department of Thaksin University, which has adopted the cooperative education framework from SUT.

The cooperative education process can be divided into three distinct phases: the pre-cooperative phase, the during-cooperative phase, and the post-cooperative phase. The pre-cooperative phase involves identifying a suitable workplace, completing the official process for obtaining a request

letter, and preparing students for their placements. The during-cooperative phase focuses on the students' actual work experience, which includes the submission of several formal reports to the program, the documentation of daily work logs, participation in a cooperative project, and the process of monitoring and evaluation by a cooperative education advisor. The post-cooperative phase involves the submission of reports and presentations that summarize the students' experiences and learning outcomes, along with a reflection and evaluation process by stakeholders aimed at improving the overall process. To ensure the efficiency and effectiveness of internships and cooperative education programs, educational institutions have developed information systems to assist in management and administration [6, 7].

The concept of cooperative education has evolved into Cooperative and Work-Integrated Learning (CWIE) [8]. In response, the Ministry of Higher Education, Research, and Innovation developed the CWIE platform [9], a portal website for organizations, students, and universities that compiles CWIE activities from various institutions. This platform offers comprehensive information, including a database of organizations, students, and universities. However, because the data is entered by stakeholders themselves, it may not fully support the cooperative education process effectively. Many universities that implement cooperative education have developed their own systems to streamline and facilitate the process. For instance, Suranaree University of Technology (SUT) uses a CWIE management system [10], Walailuk University has its own coop system [11], Sripatum University operates a coop online system [12], and Thonburi University has a CWIE management database [13]. Thaksin University also provides a coop website [14] that includes the cooperative education schedule and a student placement database for the pre-cooperative phase. This system does not support the management of activities during the cooperative and post-cooperative phases. SmartCWE was developed to fill this gap and effectively manage the during-cooperative phase.

2.2 Agile and Cooperative Education Process

Agile [15] is a project management approach defined by its iterative development, adaptability, and ability to respond quickly to change. It focuses on continuous improvement, collaboration, and incorporating customer feedback, enabling teams to deliver small, incremental updates rather than waiting to release a fully completed product. Improve the efficiency and flexibility of managing the various processes involved. Agile principles, such as iterative development and regular feedback loops, allow institutions to continuously adapt the system to the changing needs of students, faculty, and industry partners. For example, in the pre-cooperative phase, Agile can facilitate the quick rollout of features that connect students with appropriate organizations using feedback from previous cycles. During the cooperative phase, Agile practices allow for real-time monitoring and adjustments to student placements or project requirements, ensuring all stakeholders' needs are quickly met. In the post-cooperative phase, Agile supports continuous improvement of the management system by incorporating feedback and evaluations from students and employers. This approach creates a dynamic and adaptable cooperative education management system that closely aligns with the needs of all participants.

3 SYSTEM DESIGN AND ARCHITECTURE

Initially, a web-based co-op management application was developed using the waterfall model. Requirements gathered from the program committee focused on tracking student internship progress. Data Flow Diagrams (DFD) and Entity-Relationship Diagrams (ERD) were used to design the system architecture, logic, and database. Built with PHP and MySQL, the application underwent its first pilot test with third-year students in 2017.

Based on user feedback, the system was enhanced with an evaluation module, a cooperation request document process, and faculty advisor assignment for internship supervision and guidance. Ongoing annual improvements based on student and faculty input have evolved the system to fully support the cooperative education process.

The system was upgraded to the Laravel framework in 2020 to enhance security and transition to an Agile development approach [4]. This methodology enables incremental development and continuous integration of stakeholder feedback, guided by these core principles:

1. User-Centric Approach: Focuses on creating features that address real-world challenges in managing cooperative education programs.
2. Iterative Process: Enables us to deliver value quickly and make frequent adjustments based on user feedback.
3. Continuous Feedback and Improvement: Ensures that the system continually meets the needs of stakeholders.
4. Flexibility and Adaptability: Allows us to quickly adjust to new requirements, emerging technologies, or changes in cooperative education policies and practices.

3.1 SmartCWE Components

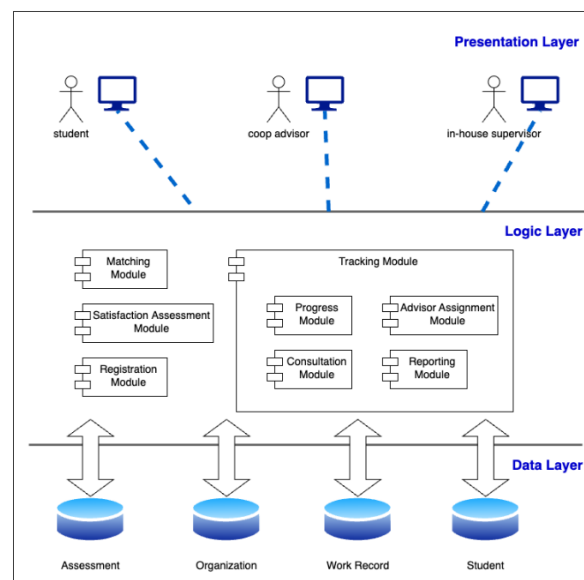


Figure 1 : SmartCWE Architecture

The architecture of SmartCWE, as shown in Figure 1, follows a three-tier structure designed for efficient management and real-time data processing.

1. The presentation layer is represented by the web interface, where three user types interact with the system via web pages. The interface is built using web technologies like HTML, CSS, and JavaScript frameworks, ensuring a responsive and user-friendly experience across devices. This layer communicates directly with the application layer, where user requests are processed.
2. The application layer or the logic layer contains the business logic that powers the cooperative education process. It is developed using the Laravel PHP framework and includes the following modules:
 - The Registration Module allows users to sign up, submit documents, and manage organization profiles.
 - The Matching Algorithm module is powered by a rules-based engine to match students with suitable co-op opportunities based on their skill sets and preferences.
 - The Tracking Module enables cooperative advisors and students to record work activities, track performance, and generate custom reports.
 - The Consultation Module allows advisors to provide real-time feedback based on student activity logs and work records.
 - Advisor Assignment Module allows administrators to manually assign cooperative advisors to students, ensuring proper supervision and support throughout the co-op process.
 - The Satisfaction Assessment Module allows students, advisors, and in-house mentors to give feedback on their co-op experience.
3. The data layer stores essential information in relational databases, MySQL, which support the system's real-time data processing needs. It contains key databases for:
 - Assessment Data: stores evaluation records and feedback from various stakeholders.
 - Organization Data: manages the profiles and details of organization participating in the cooperative education program.
 - Work Records: logs students' daily work progress. This allows accurate monitoring of student performance and provides advisors with detailed insights.
 - Student Data: Manages student profiles, personal details, and records of completed co-op placements.

4 IMPLEMENTATION AND EVALUATION

SmartCWE was initially developed using PHP and later transitioned to the Laravel framework for system development, with MySQL serving as the data storage solution. In its latest version, the system categorizes users into three types: cooperative students, cooperative advisors, and in-house mentor. The following section outlines the functionalities available to each type of user.

4.1 Cooperative Student Functionalities

As described above, students who wish to participate in cooperative education must first register their profile in the system. For organization selection, students have the option to choose from existing organization in the database or to add a new one. The organizations currently in the database are those that have been previously utilized by students and have received approval from cooperative advisors. The system provides the following functionalities for students.

- Request for cooperative education: This feature manages the document control process associated with the pre-cooperative phase, as illustrated in Figure 2.
- Daily progress: This feature facilitates activities during the cooperative phase by enabling students to record their daily responsibilities, edit work logs, and access information related to cooperative education. Students can document their work either at the time of completion or retrospectively, including images related to their tasks.
- Matching skills: This feature is designed to identify suitable workplaces that correspond to the skills students wish to develop, as depicted in Figure 3. The matching algorithm operates by organization job descriptions in the organization database with the skills specified in the student database.
- Explore workplace: This feature enables users to browse the organization database and add new entries. Figure 5 shows a part of the template screen used for adding a new organization, which is based on matching rules such as job descriptions.
- Evaluation: This feature enables students to evaluate the counseling provided by faculty advisors as well as the instruction received from the in-house mentor. The results from both evaluations are utilized for the purpose of continuous improvement.

บันทึกข้อมูลขอฝึกสหกิจ (Cooperative Education Training Request Form)

บันทึกข้อมูลขอฝึกสหกิจ (Cooperative Education Training Request Form)

รหัสฝึก (Student ID) ชื่อ-สกุล (Name-Surname)
642021200 นางสาวบุษรา สุขุม

ปีการศึกษา (Academic Year) ปีที่เรียน (Year of Study) วันที่เริ่ม (Start Date) วันที่สิ้นสุด (End Date) ระยะเวลาฝึกสหกิจ (Duration)
Enter '2567' Enter '3-4' คำนวณ (calculate)

*** ระยะเวลาฝึกสหกิจ รวมเสาร์-อาทิตย์ และวันหยุดนักขัตฤกษ์แล้ว ไม่น้อยกว่า 90 วัน (The cooperative education period shall not be less than 120 days)

ขอให้นักวิชา จัดส่งหนังสือขอความอนุเคราะห์ฝึกสหกิจถึงหน่วยงานทางไปรษณีย์ (Request the faculty to send documents to the organization)
ข้าพเจ้าจะนำหนังสือขอความอนุเคราะห์ฝึกสหกิจไปส่งหน่วยงานด้วยตนเอง (Self-delivery)

เรียน (To) หน่วยงาน (Organization)
ตำแหน่งหัวหน้าหน่วยงาน (Head of Department/Division) เลือกหน่วยงาน (Select Organization)

แนบฟอร์มขออนุญาตผู้ปกครอง จำนวน 1 ฉบับ (Parental Consent Form 1 copy)
Choose File no file selected

แนบรูปส่วนตัว (Resume) พร้อมติดรูปถ่าย 1 นิ้ว จำนวน 1 ฉบับ (Student's Personal Profile (resume) with 1-inch photograph)
Choose File no file selected

แนบใบแสดงผลการเรียน 5 ภาคการเรียนปกติ (Transcript) จำนวน 1 ฉบับ (Academic Transcript of 5 semesters 1 copy)
Choose File no file selected

บันทึก

Figure 2 : A screen for inputting the necessary student information for cooperative education, which serves as an official document of Thaksin University.

Organization Matching

Skills to be developed

☐ graphic design ☐ front-end development ☐ back-end development ☐ mobile app

☐ technical support ☐ software testing ☐ data analysis ☐ network administration

Figure 3 : An example interface for selecting the hard skills a student aims to enhance, with corresponding results displayed in Figure 4.

List of Companies Matching Selected Skills

front-end development

#	ชื่อบริษัท (Organization name)	ที่อยู่ (Address)	หมายเลขโทรศัพท์ (Telephone)
1	HoneyCorporation Co., Ltd.	56/31 Pantaynorasing Amphor MuangSamutsakorn Samutsakorn 74000	092-324-2995
2	Customix Co., Ltd.	64/3 Moo 1 Tambol Surasak Amohor Sriracha Chonburi 20110	092-756-5971
3	BizPotential Co., Ltd.	807/1 Praram 3 Bangpongpang Yannawa Bangkok 10210	02-683-3061
4	JobBKK Dot Com Co., Ltd.	625 Tasneeya Building Floor 5 Soi Ramkamhang 39 Prachauthit road Wangthonglang Bangkok 10310	02-514-7471
5	Salatondesign Co., Ltd.	98/3 Moo 11 Tambol Bangranard Amphor Nongcheng Yala 95000	089-597-6551

Figure 4 : The matching results generated from the selected front-end development data

ประเภทหน่วยงาน * (Organization Unit Type)

☐ โรงแรม (Hotel) ☐ โรงพยาบาล (Hospital) ☐ หน่วยงานราชการ (Organization Agency) ☐ รัฐวิสาหกิจ (State Enterprise) ☐ บริษัท (Company)

คำอธิบาย * (Job Description)

Choose..

Choose..

Figure 5 : An additional section of the organization information template screen utilized in the matching algorithm

To improve the organizational data utilized by the matching algorithm within the Agile framework, additional data for matching criteria has been incorporated. This data storage includes information on aligning students with organizations based on the academic skills students wish to develop and the specific job characteristics of the organization.

4.2 Cooperative Advisor Functionalities

The cooperative advisor is a faculty member assigned to oversee students in the cooperative education program. Their responsibilities include monitoring student progress, conducting site visits, and providing counseling. All faculty data is preloaded into the system. An administrator assign faculty members to students based on data from the previous year or specific requests from the lecturers. The functionalities available to cooperative advisors include:

- Browsing students under supervision: This feature allows cooperative advisors to view detailed information about the students assigned to them upon logging in. It also provides scheduled appointment dates for supervisory visits.
- Tracking student progress: This feature enables advisors to monitor the progress of each student under their supervision. It is integrated with the student's daily progress module and allows advisors to offer guidance and counseling as needed.
- Evaluation: This feature provides a questionnaire for advisors to evaluate both students and organizations. The results from the student evaluations are used to identify areas for student improvement, while the evaluations of organizations are used to determine their suitability as future cooperative education sites for students.

4.3 In-house Mentor Functionalities

The in-house mentor is either the head of the organization or agency where the student is undertaking cooperative education or an individual designated by the organization to oversee the cooperative education student. SmartCWE provides these functionalities:

Approving student work: This feature allows in-house mentor to monitor student progress and approve their work, ensuring that the student's work log is accurate and aligns with the planned activities.

Evaluation: This feature offers tools for in-house mentor to evaluate students, emphasizing both hard and soft skills in accordance with the program's learning outcomes. The evaluation questionnaire assesses competencies such as algorithmic and critical thinking, system development, communication, and self-learning skills. Additionally, it provides a section for recommending improvements for both the students and the program. The collected feedback is utilized to inform students and to enhance the overall quality of the program.

4.4 SmartCWE for Continuing Improvement

Our goal in continuously enhancing SmartCWE is to ensure it remains a valuable resource for students, faculty, and employers involved in the cooperative education process. Each development cycle includes evaluating the system's user experience and benefits, primarily based on student satisfaction. Cooperative advisors also assess its functionality and adaptability to evolving educational needs. Over the past three years, data from 76 students, selected based on participation in the co-op program, were collected through online questionnaires. Additionally, feedback from focus group discussions with cooperative advisors and the program committee was gathered to further guide development. After each system implementation, a satisfaction evaluation is conducted, and feedback is gathered to guide system improvements. Additional functionalities are incorporated and deployed in subsequent years. This iterative process is continually applied to ensure comprehensive coverage of the entire cooperative education process. Table 1 presents the student satisfaction results, with values ranging from 1 (very dissatisfied) to 5 (very satisfied), reflecting key factors such as system usability, interface design, and overall benefits of the system. To ensure the reliability of these results, data validity was confirmed through feedback collected over multiple years. Table 2 provides a summary of the iterative development process, integrating feedback by combining quantitative data

from questionnaires with qualitative insights from focus groups to ensure the accuracy and relevance of each system enhancement.

Table 1 : Satisfaction level according to student assessments

Satisfaction Item	2021 (21 students)	2022 (18 students)	2023 (27 students)
The overall experience of using the system	3.74	4.11	4.15
The user interface design	3.84	4.17	4.22
The effectiveness in supporting the management of cooperative education	4.00	4.17	4.33

Table 2 : Iterative development informed by feedback from cooperative advisors and the program committee

Academic year	Important functional improvements
2020	- Introduced in the cooperative phase, including student registration and organization profile - Daily work logging and report generation - Appointment scheduling
2021	- Development of counseling module - Development of an evaluation module for advisors - Implementation of a feature that allows photos to be added to daily work entries
2022	- Implementation of an evaluation module for students - Creating an official portal for cooperative education documents as defined by the Academic Affairs Department
2023	- Improving the application and document submission process - Development of a skill-matching feature for selecting suitable organizational workplaces - Integration of in-house mentor functionalities - Enhancement of the user interface

5 CONCLUSION AND FUTURE WORK

This paper presents the development of SmartCWE, a tool designed to track third-year students during internships to meet the needs of the Computer Science Program. In 2020, the system has changed from PHP to Laravel and adopted an Agile methodology for continuous improvement. Key features include student registration, workplace matching, work logging, and report generation, allowing advisors and mentors to monitor student progress and perform assessments aligned with cooperative education standards.

The study evaluates both the system development and student learning outcomes. Feedback shows improvements in student performance, placement quality, and supervision. These enhancements support the development of high-skilled professionals for Thailand's digital industry. SmartCWE effectively manages cooperative education, with ongoing updates increasing user satisfaction. Future work will integrate skill recommendations, document management, and site visit feedback to further boost student employability.

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