Journal of Innovative Technology Convergence
Vol. 5, No. 2 December 2023, pp. 23-34

A Prototype Development of a Mobile Schedule Viewer Integrating QR Code Technology and Decorator Design Pattern for Effective Dissemination of Class Schedules

Myra Shane T. Aretaño [1], Abegail Christine T. Bada [2], Antonette B. Fabila [3], Wenielyn J. Sadje [4], Jason P. Sermeno [5*]

Abstract: Class schedules undergo continuous changes with each new release, making manual scheduling a complex task. To address this issue, this study proposes integrating a mobile application that enables students to promptly access their accurate class schedules. A prototype mobile schedule viewer was developed to identify and resolve conflicts arising from conflicting schedules. The study confirmed the functionality and stability of the spreadsheet application, as the mobile schedule viewer successfully employed the decorator design pattern and integrated QR code generator plugins. These plugins facilitated the extraction of existing schedule files from the University Integrated Information System (UIIS). The overall findings indicate that the applications are 95 percent complete in terms of degree of completeness (DOC) and boast a record level of accuracy (RLA) of 95 percent.

Keywords: Mobile schedule viewer, QR code technology, Decorator design pattern, Class schedules

1. Introduction

Scheduling difficulties are problems in allocating resources across time to fulfill a set of actions that are part of a process, the most common of which are computing and manufacturing processes. Personnel,

[1] College of Computer Studies, University of Antique, Sibalom, Antique, Philippines
Email: msaretano@gmail.com
[2] College of Computer Studies, University of Antique, Sibalom, Antique, Philippines
Email: abegailchristinebada@gmail.com
[3] College of Computer Studies, University of Antique, Sibalom, Antique, Philippines
Email: athone010800@gmail.com
[4] College of Computer Studies, University of Antique, Sibalom, Antique, Philippines
Email: sadjewenielyn@gmail.com
[5*] College of Computer Studies, University of Antique, Sibalom, Antique, Philippines
Email: jasonpsermeno@gmail.com (Corresponding Author)

Received [January 8, 2023]; Revised [April 2, 2023]; Accepted [June 16, 2023]

Published by InnoCon Publishing
ISSN 2704-4440

money, processors (machines), energy, and equipment are all resources that individual activities compete for. Task characteristics such as ready times, due dates, relative urgency weights, and task processing functions in relation to provided resources are all the same. Furthermore, the structure of a set of tasks, which shows links between them, may be defined in a number of ways. Furthermore, numerous factors for evaluating the quality of a set of tasks' performance might be taken into account.

Quick Response (QR) codes are widely used in various settings, such as consumer advertising, commercial tracking, ticketing, and marketing. Although QR codes offer convenience, scanning them indiscriminately poses risks. There is no inherent assurance of the code's safety or the accuracy of its destination. Malicious actors can exploit QR codes to direct users to counterfeit websites aimed at phishing personal information or infecting mobile devices with malware [1].

In academic environments, scheduling complexities are encountered, yet viable solutions exist. One proposed method involves instructors engaging with a system to generate secure QR codes containing pertinent class details, thereby circumventing common design limitations inherent in certain scheduling systems [2]. Additionally, the utilization of pre-designed templates, formulated to resolve recurrent issues, offers a time-saving approach, enhancing efficiency and efficacy in academic presentations. This can be done at any time before the class.

University timetabling software has advanced dramatically as a result of technological improvements. These software alternatives began as custom-built solutions and have grown to automatically build and improve schedules, increasing their accessibility. According to studies, major manufacturers have incorporated a variety of capabilities, including spreadsheets, databases, timetabling editors, online access, and improved interfaces. As a result, these applications may now use cutting-edge strategies for scheduling efficiently [3].

Additionally, Arratia-Martinez *et al.* [4] emphasized that a schedule proves advantageous when it's feasible and satisfies the needs of the students and members who will utilize it to some extent. For instance, many students may favor a condensed schedule over a more spread-out one. Nonetheless, manually creating such schedules can be overwhelming for institutions.

Students and faculty at the University of Antique struggled with their instructional schedules. They have access to their class schedule, which is displayed on the bulletin boards and on the walls of the classroom. Traditional and manual schedule viewers have brought complexity and ambiguity to instructors and students, as it has become inconvenient for them because there are some instances where this type of scheduling is ineffective in disseminating reliable and updated class schedules to those subjects who rely on this type of dissemination scheme. There is always complexity in using this manual scheduling due to the fact that class schedules are constantly changing every moment when there is an updated schedule. As a result, in order to alleviate the confusion, chasing times, and inconveniences experienced by both students and teachers at the University of Antique in locating and waiting for an updated and accurate class schedule, a mobile application is integrated that allows students to quickly locate their correct class schedule.

This study generally aims to develop a prototype for a mobile schedule viewer using QR code technology and applying the decorator design pattern. Specifically, the study aims to:

1. Design and create a structured schedule for classes, instructors, and rooms using an online spreadsheet application with QR-code generator plug-ins that could copy and paste an existing schedule file from the University Integrated Information System (UIIS).
2. Design and create a mobile schedule viewer utilizing the decorator design pattern for viewing the scanned schedule in expanded matrix format.

2. Related Technologies

2.1 QR Code

While QR codes are not a new technology, they are nevertheless commonly used for sending data through pictures. QR code technology is used in conjunction with an enhanced Mobile Technology Acceptance Model to identify important elements influencing m-payment adoption aspirations [5]. QR codes are extensively used in a variety of scenarios, including consumer advertising, commercial tracking, ticketing, and marketing. People frequently scan QR codes and believe in the information they contain. However, there is no established mechanism for ensuring the validity and secrecy of code content. Attacks such as redirecting to a rogue website or infecting a smartphone with malware are both realistic and viable [1].

QR codes can be used as a recognition method, a user authentication solution that may involve cell phones reading a QR code that can be easily granted and transmitting it to a server for authentication [6]. It has the advantage of simplifying the authentication procedure while reducing the risks of brute force attacks, man-in-the-middle attacks, and keyboard hacking that can occur with other authentication systems.

In addition, to simplify the check-in procedure for train travel, Muthukumar *et al.* [7] proposed to include a QR code and fingerprint-based identification technique. Passengers can use QR codes to indicate their presence at their seat. Fingerprint authentication verifies a person's identity without the requirement of physical identification. This technique seeks to solve the inefficiencies and time-consuming nature of the present ticket-checking system, which manually validates each passenger's ticket and identity. By using this strategy, a more efficient system was developed that saves time and lowers the possibility of human mistakes.

Figure 1. QR Code

A QR code, or Quick Response code, as shown in Figure 1, is a sort of barcode that mobile phones can quickly scan. This 2D matrix barcode uses a pattern of spaces to store information. It scans and sends numerous sorts of data. QR codes are widely used in a variety of industries, including retail, marketing, and logistics, due to their versatility. Digital equipment can easily decode them, as they encode information in a grid of square pixels [8].

2.2 Google Sheets

The Google Sheets Application Programming Interface (API) is a RESTful interface that lets you read and modify a spreadsheet's data [9]. Its most common uses involve creating spreadsheets, reading and writing spreadsheet cell values, updating spreadsheet formatting, and managing connected sheets.

A design solution based on Google Sheets provides flexibility, simplicity of adaptation, and low resource needs in terms of both human resources and expenses. The dashboard should provide information to assist the institution in improving the distance learning experience [10]. In the study of Castro [11], students are provided with a Google Sheets workbook with various weekly interactive assignments. It is capable of automatically adding up points, making a pie chart, displaying comparisons, and having all the grades and feedback on the front page.

In addition, Google Sheets can aid library information systems in bringing data into a format for easy search and retrieval [12]. Web scraping tools built into Google Sheets can be used to find aids in Hypertext Markup Language (HTML) webpages to harvest the data. In this regard, comma-separated values (CSV) files can be created and converted into MAchine-Readable Cataloging (MARC) records in batches, getting them ready for usage in any library system.

2.3 Design Pattern

A design pattern can be derived directly from code or design without the need for an existing pattern library. The idea analysis technique, as modified for this purpose, can find class groupings that have a common, repeating pattern. Concept analysis identifies collections of objects with similar qualities, which correspond to class members or inter-class interactions in the context of object-oriented design patterns. The approach was applied to a C++ application, where the structural relationships among classes led to the extraction of a set of structural design patterns. These patterns were supplemented with non-structural data about class members and method calls. The generated patterns can be seen as meaningful structures aimed at solving generic challenges involving several instances of the investigated program.

Design patterns are best practices that programmers may use to overcome typical design difficulties in applications or systems. Essentially, a design pattern is a generic and reusable solution to a common problem. It is not a completed design that can be simply transformed into source code, but rather a description or template for solving a problem that may be used in a variety of contexts [13]. A design pattern is a specialized method of recording design information so that previous successful solutions may be used in comparable situations in the future. A collection of design patterns may help both expert and inexperienced designers identify circumstances where design reuse is conceivable or beneficial. Design patterns are considered an effective way to communicate complex concepts between designers, can be used to document and promote the reuse of best practices, and capture the essential elements of a design in a concise form, which is useful for documenting existing software architectures. These reasons have been the motivation for using design patterns in exchanging knowledge and building on one another's experiences [14].

2.3 Decorator Design Pattern

The decorator design pattern is a structural design pattern that focuses on class and object composition, allowing additional responsibilities to be added to objects dynamically. This pattern involves creating a decorator class that wraps the original class, providing extra functionality while keeping the class methods' signatures unchanged. It is similar to the chain of responsibility pattern, but with a key difference: in the chain of responsibility pattern, only one class handles the request, whereas in the decorator design pattern, all classes handle the request. Implementing the decorator pattern often results in a system made up of many small objects that appear similar [15].

Extensive classroom-based research has been undertaken over the last few decades, with most of the cutting-edge literature concentrating on classic classroom scheduling challenges. Sermeno and Secugal

[16] have proposed a flat-fading-based strategy for classroom education and stated that replicating this technique using MATLAB can considerably degrade its performance due to its computational complexity. A decorator dynamically adds new responsibilities to an object, providing a more flexible alternative to subclassing for extending functionality. The facade pattern, on the other hand, provides a single interface to a collection of interfaces in a subsystem, generally creating a higher-level interface that simplifies the subsystem's usage [16][17].

3. The Proposed Mobile Schedule Viewer

This study focused on the prototype development of a mobile schedule viewer integrating QR code technology and decorator design patterns for an effective dissemination of class schedules to help students access updated schedules due to some complex changes in class schedules and to convert the use of manual and traditional class schedules into a modern mobile schedule viewer using QR codes. The architectural framework for the proposed mobile schedule viewer is shown in Figure 2.

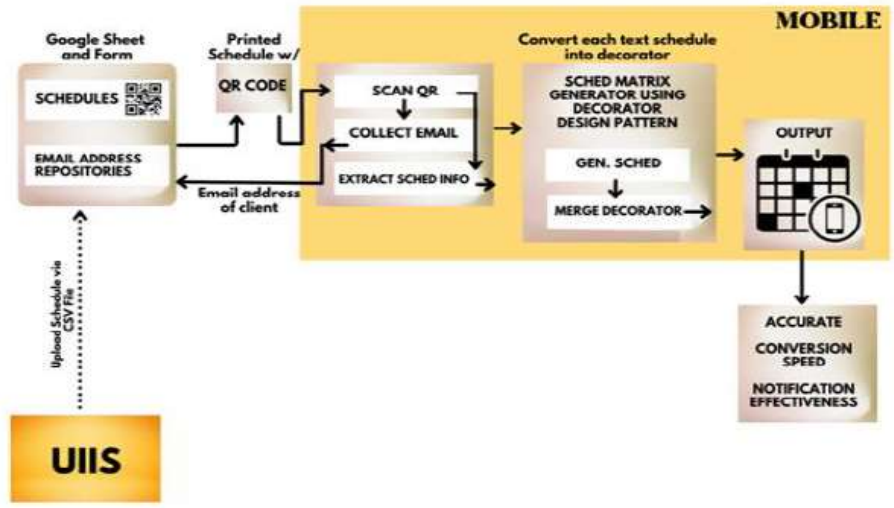

Figure 2. Architectural Framework

This study is primarily designed for the students and instructors of the University of Antique (UA). This remarkable idea has made a great contribution to the university's challenges in facing the inconveniences that students face in finding their class schedule and in replacing the traditional and manual way of making updated class schedules.

The system relies on the data from the UIIS in the form of a CSV file, which could be generated upon request from the UIIS. Once generated, it can be uploaded to the system since the file is compatible with the Google Sheets of the system. The client will log in first before scanning. The client needs to input their antiquespride.edu.ph email address and the QR code for email confirmation that a student is connected to the schedule. The user will log in first and scan the QR code; next, the system will collect the emails and return them to the Google form. After scanning, the system will extract class schedule information and convert it to each text schedule matrix generator using the decorator design pattern; then the system will generate the class schedule and merge the data of the schedule into the decorator; then the class schedule output will appear on the mobile screen of a client; and lastly, the team proponent will test if the system attains its record level of accuracy and degree of completeness.

The Graphical User Interface (GUI) for logging in is displayed in Figure 3. Before scanning the QR code of their corresponding schedules, the student will need to enter their username or antiquespride.edu.ph email address.

Figure 3. GUI of the Mobile Schedule Viewer

Before students see their schedules, they will scan the QR code in Figure 4 to display the decorator design pattern in matrix format from which their individual schedules were derived. This QR code was created using a Google Sheet API.

Figure 4. Scanning of the QR Code of Schedules

After scanning the QR code, Figure 5 displays the decorator design pattern in matrix format in the mobile schedule viewer. The school year, semester, year, section, the student's email address who scanned the QR code, the day and hour of the schedule, the instructor, and the subjects are displayed in matrix format. The go back button is located under the schedules for students to use if they have previously seen the schedule and want to leave.

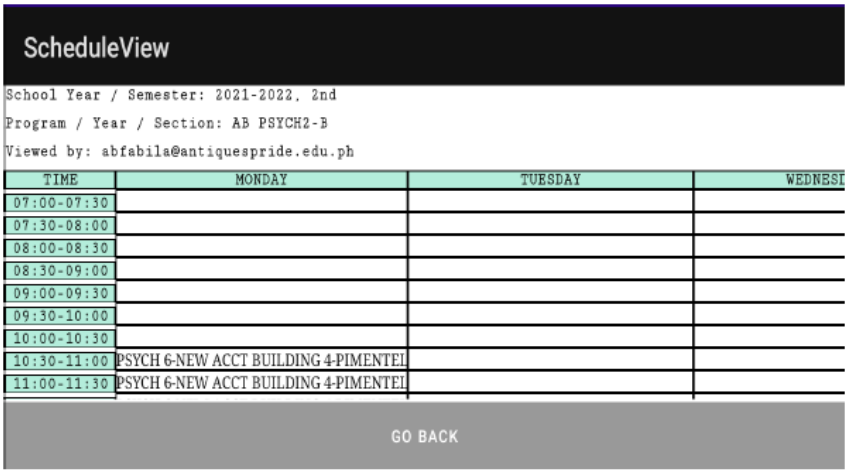

Figure 5. Output Screen after Viewing the Schedule

The spread sheet in Figure 5 depicts the schedule data that was utilized by the developers to combine the form of the QR code with the Google API, where the user would enter the schedule data for each program.

4. Results and Discussion

The forty schedules from the University of Antique's several colleges for the second semester of the academic year 2021–2022 were used to test the completeness and record level of accuracy of the proposed mobile schedule viewer. For evaluation purposes, all departments in UA, including the College of Arts and Sciences (CAS), the College of Business and Accountancy (CBA), the College of Teacher Education (CTE), the College of Computer Studies (CCS), the College of Engineering and Architecture (CEA), the College of Maritime Studies (CMS), and the College of Technology (COT), will be the test subjects to find out how complete and accurate the mobile schedule viewer application system is.

4.1 Degree of Completeness and Record Level of Accuracy

The number of entries for degree of completeness and record level of accuracy are shown in Table 1. Six entries from the CAS schedule, nine entries from the CBA schedule, eight entries from the CTE, three entries from the CCS, five entries from the CEA, two entries from the CMS, and seven entries from the COT allowed them to calculate the degree of accuracy and completeness, and all the respondents received a result of 95% percent. Subsequently, it can be stated that the mobile application is 95% complete and 95% accurate in its production of schedule data. The record level of accuracy also demonstrates a 95% percent accurate data set, which enables the mobile app to produce successful and accurate data.

Table 1. Degree of Completeness and Record Level of Accuracy Results

Case No.	Random Selected Courses	Total No. of Entries	No. of Observed Schedule Entries	Degree of Completeness	Record Level of Accuracy
1	AB PSYCH 2B	3	3	100%	100%
2	AB PSYCH 3A	5	5	100%	100%
3	AB PSYCH 2A	2	2	100%	100%
4	BS CRIM 1H	9	9	100%	100%
5	BS CRIM 2D	9	9	100%	100%
6	BS CRIM 3A	9	9	100%	100%
7	BS ENTREP 3A	7	7	100%	100%
8	BS ENTREP OL 1A	7	7	100%	100%
9	BS ENTREP OL2B	7	7	100%	100%
10	BSBA MKTG 3A	6	6	100%	100%
11	BSHRM 3B	6	6	100%	100%
12	BSHRM 4A	1	1	100%	100%
13	BSOAD 3D	5	5	100%	100%
14	DPA 1A	3	3	100%	100%
15	MBA 3A	2	2	100%	100%
16	BECED 2A/BSNED 2A	6	6	100%	100%
17	BPED 2A	9	9	100%	100%
18	BSED 3D/BTVTED 3A	2	2	100%	100%
19	BSED 4A/BSED 4C/BSIE AUTO 4A	1	1	100%	100%
20	CIT 2B	6	6	100%	100%
21	GRADE 9A (STE)	8	8	100%	100%
22	GS2 MAEDFIL 1A	1	1	100%	100%
23	MEDC1 2A	1	1	100%	100%
24	BS COMSCI 2B	7	7	100%	100%

25	BS INFO 1E	8	8	100%	100%
26	BS INFO 2D	5	5	100%	100%
27	BS ARCH 1A	5	5	100%	100%
28	BS ARCH 3A	5	5	100%	100%
29	BSCE 1D	7	0	0%	0%
30	BSCE 4A	6	6	100%	100%
31	BSCE 5A	7	7	100%	100%
32	BSMT 1A	8	0	0%	0%
33	BSMT 2D	5	5	100%	100%
34	BAT 2A	7	7	100%	100%
35	BIT-AT 1A	7	7	100%	100%
36	BIT-FDAT 2E	1	1	100%	100%
37	BIT-FDAT 3A	1	1	100%	100%
38	BIT-FST 1J	6	6	100%	100%
39	BIT-FST 2D	8	8	100%	100%
40	BIT-FST 3B	6	6	100%	100%
			Average	**95%**	**95%**

4.2 The Overall Performance

According to the findings shown in Figure 6, the mobile application is 95 percent complete in terms of its degree of completeness (DOC) and is 95 percent accurate in terms of Record Level of Accuracy (RLA). The Google Spreadsheets with QR codes have a functional design and creation. It is attested that both the record level accuracy and degree of completeness are 95%. Overall, it is 95% functioning, 95% accurate, and 95% complete.

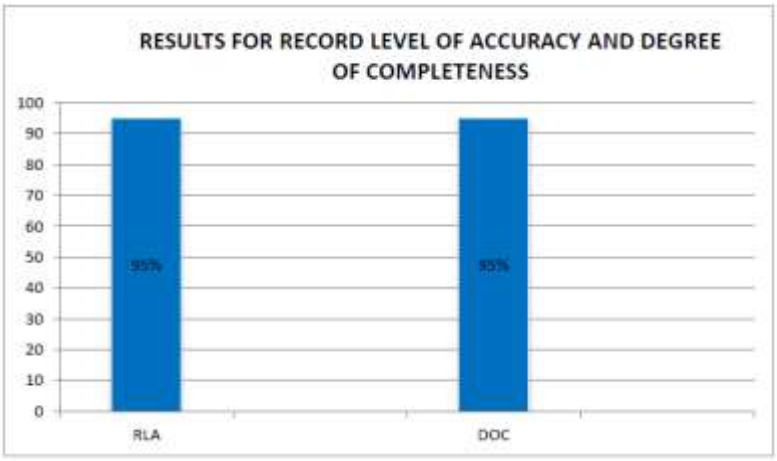

Figure 6. Results of the Overall Performance of the Mobile Schedule Viewer App

5. Conclusions and Recommendations

In this study, students can conveniently access their allocated schedules using QR codes in a mobile application with a decorator design pattern. In this regard, the process of providing a manually printed schedule and putting it on bulletin boards will be enhanced. Reposting and reprinting of schedules will also be minimized whenever newly updated schedules become available.

In addition, the following conclusions were made based on the aforementioned results:

1. The spreadsheets application is functional and stable because the mobile schedule viewer was able to utilize the decorator design pattern that is implemented with a QR-code generator plug-in that can copy-and-paste an existing schedule file from the UIIS.

2. The mobile application is able to scan the schedule using a QR code, and the schedule is displayed in matrix format.

3. The performance of the mobile schedule viewer is accurate and complete.

In the future, further enhancements will be integrated into its development, making it available in mobile or smart app stores for Android and iOS users among the students of the University of Antique.

References

[1] R. Focardi, F. L. Luccio, H. A. Wahsheh, "*Usable Security for QR Code*", Journal of Information Security and Applications, vol. 48, October 2019, doi: 10.1016/j.jisa.2019.102369.

[2] A. Magdich, Y. H. Kacem, A. Mahfoudhi, M. Kerboeuf, "*A UML/MARTE-Based Design Pattern for Semipartitioned Scheduling Analysis*", in Proc. 2014 IEEE 23rd International WETICE Conference, Parma, Italy, June 23-25, 2014, pp. 300-305, doi: 10.1109/WETICE.2014.9.

[3] R. A. Oude Vrielink, E. A. Jansen, E. W. Hans, J. Hillegersberg, "*Practices in Timetabling in Higher Education Institutions: A Systematic Review*", Annals of Operations Research, vol. 275, April 2019, pp. 145-160, doi: 10.1007/s10479-017-2688-8.

[4] N. M. Arratia-Martinez, C. Maya-Padron, P. A. Avila-Torres, "*University Course Timetabling Problem with Professor Assignment*," Mathematical Problems in Engineering, vol. 2021, Article ID 6617177, January 2021, doi: 10.1155/2021/6617177.

[5] L. Y. Yan, G. W. H. Tan, X. M. Loh, J. J. Hew, K. B. Ooi, "*QR Code and Mobile Payment: The Disruptive Forces in Retail*", Journal of Retailing and Consumer Services, vol. 58, January 2021, doi: 10.1016/j.jretconser.2020.102300.

[6] Y. G. Kim, M. S. Jun, "*A Design of User Authentication System Using QR Code Identifying Method*", in Proc. 6th International Conference on Computer Sciences and Convergence Information Technology, November 29, 2011, Seogwipo, South Korea, pp. 31-35, www.ieeexplore.ieee.org/document/6316569.

[7] B. Muthukumar, J. A. Mayan, G. Nambiar, D. Nair, "*QR Code and Biometric Based Authentication System for Trains*", in Proc. International Conference on Frontiers in Materials and Smart System Technologies, April 10, 2019, Tamil Nadu, India, doi: 10.1088/1757-899x/590/1/012010.

[8] V. Chang, W. Chen, Q. A. Xu, C. Xiong, *"Towards the Customers' Intention to Use QR Codes in Mobile Payments*", Journal of Global Information Management, vol. 29, no. 6, January 2021, pp. 1-21, doi: 10.4018/JGIM.20211101.oa37.

[9] Google Workspace, "*Google Sheets API Overview*", https://developers.google.com/sheets/api/guides/concepts (Accessed January 3, 2023).

[10] A. Rahmah, P. Sukmasetya, M. S. Romadhon, A. R. Adriansyah, "*Developing Distance Learning Monitoring Dashboard with Google Sheet: An Approach for Flexible and Low-Price Solution in Pandemic Era*", in Proc. 2020 International Conference on ICT for Smart Society (ICISS), Bandung, Indonesia, November 19-20, 2020, pp. 1-6, doi: 10.1109/ICISS50791.2020.9307558.

[11] D. Castro, "*Google Sheet Workbook Weekly Activities*", The California State University, https://scholarworks.calstate.edu/concern/educational_resources/cc08hp38w (Accessed January 3, 2023).

[12] J. A. Salim, A. Saraiva, "*A Google Sheet Add-on for Biodiversity Data Standardization and Sharing*", Biodiversity Information Science and Standards, vol. 4, October 2020, doi: 10.3897/biss.4.59228.

[13] P. Tonella, G. Antoniol, "*Object Oriented Design Pattern Inference*", in Proc. IEEE International Conference on Software Maintenance - 1999 (ICSM'99). 'Software Maintenance for Business Change' (Cat. No.99CB36360), Oxford, UK, August 30 – September 3, 1999, pp. 230-238, doi: 10.1109/ICSM.1999.792619.

[14] K. Beck, R. Crocker, G. Meszaros, J. Coplien, L. Dominick, F. Paulisch, J. Vlissides, "*Industrial Experience with Design Patterns*", in Proc. IEEE 18th International Conference on Software Engineering, Berlin, Germany, March 25-30, 1996, pp. 103-114, doi: 10.1109/ICSE.1996.493406.

[15] T. O'Reilly, "*What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software*", International Journal of Digital Economics, no. 65, March 2007, pp. 17-37, www.mpra.ub.uni-muenchen.de/id/eprint/4580.

[16] J. P. Sermeno, K. A. S. Secugal, "*Class Scheduling Framework Using Decorator and Façade Design Pattern*", In Proc. 2021 Second International Conference on Innovative Technology Convergence (CITC), Sibalom, Philippines, December 2021, pp. 38-45, doi: 10.1109/CITC54365.2021.00015.

[17] J. P. Sermeno, J. J. D. Orquia, "*CORBA-Based Class Scheduling Framework Using Decorator and Facade Design Patterns*", Journal of Innovative Technology Convergence, vol. 3, no. 1, June 2021, pp. 9-22, doi: 10.69478/JITC2021v3n1a02.