Research Article

ACCEPTABILITY OF AN ATTENDANCE MONITORING SYSTEM USING QR CODE AMONG COLLEGE INSTRUCTORS AND STUDENTS

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Abstract

The widespread availability and usage of QR (Quick Response) Code technology has spurred on various innovations aimed at providing more convenient and faster access to information. In the field of education, this technology has been utilized in mechanisms that facilitate efficient monitoring of attendance. In this study, a QR Code-based attendance monitoring system that simplifies the processes involved in its usage is proposed. This paper then describes the configuration and implementation details of the system. In order to determine its acceptability, 32 instructors and 98 students were asked to respond to a 5-point Likert questionnaire based on the prescribed standards for evaluating the project's software quality. Results show that the respondents mostly indicated either highly acceptable or acceptable ratings across all criteria, namely functionality, reliability, usability, efficiency, and maintainability. Further analysis of the data using Welch's t-test confirmed a significant difference in the ratings of the instructors and those of the students. Overall, the results show that the instructors had a higher level of acceptability than the students. The results of this study indicate that the system can be adopted and utilized as a viable means for checking students' attendance on the campus.

Keywords: Attendance Monitoring System, Acceptability, Evaluation, QR Code

Introduction

The importance of regularly monitoring student's attendance has been underscored in contemporary tertiary education. Detailed guidelines on attendance are frequently discussed and enforced by instructors in their course policies and requirements as part of their classroom management practices (Al-Shammari, 2016). After all, the link between attendance and positive academic outcomes has been established in the literature. In the context of academic performance, a meta-analysis reveals that class attendance in college is strongly related to class grades and GPA (Credé et al., 2010).

The documented significance of class attendance has prompted technology experts to devise ways by which the process of checking attendance can become more convenient and efficient. This is also a direct response to the conventional paper-and-pen mode of taking attendance, which is characterized by its routine and demanding process (Hendry et al., 2017). Applying this traditional mode to a large class size requires even much more time, indicating the possibility that a number of hours that should have been devoted to lecture-discussion are given up just for the checking process (Masalha & Hirzallah, 2014).

Capitalizing on the availability and accessibility of computer and mobile technologies can innovate the process of monitoring attendance. Particularly, the adoption of the QR (Quick Response) Code technology has been regarded as a viable means of developing an attendance system. Capable of storing a large amount of information, QR Code is a two-dimensional barcode that consists of black elements or modules organized in a square pattern on a white background (Denso ADC, 2012; Hossain et al., 2018). From its initial application in the Japanese automotive industry, QR Code has made its reach to several industries, including healthcare (Czuszynski & Ruminski, 2014), marketing (Asare & Asare, 2015), and transportation (Aulya et al., 2016).

Aside from its large storage capacity, QR Code is also known for its fast recognition and readability, making it a frequently used application for connecting to a website, watching a video, or accessing text-based information. The increasing popularity of mobile technology applications has resulted in the development of various QR Code readers, scanners, and generators that are compatible with Android and iOS devices (Koh et al., 2017). The extraction and reading of the code patterns are easily done using the device's built-in camera.

In recent years, there has been an increased interest in the development of an attendance system using QR Code. Baban (2014) developed an attendance checking system for a university to determine the rate of absenteeism among students. The instructors were required to send Excel

spreadsheets to the attendance system administrator that managed a MySQL database. They also posted QR Codes on the doors of their respective rooms so that students could scan them anytime using their smartphones to check their attendance. The author maintained that the system was capable of securing the students' attendance records and making them private.

In another attendance system project that guaranteed the security of students' details, Jadhav, Gagare et al. (2018) came up with a semi-automated system that required minimal costs in terms of hardware and software components. Each student was given a QR Code containing all the attendance-related information. In confirming the student's attendance, the code should be scanned by an Android device, and the information would be stored and updated in an online database. The attendance list could be transferred by the instructors to their personal computers or laptops.

Maximizing the usage of online database platform and mobile technology, Rahni et al. (2015) integrated QR Codes in developing the cost-effective SAMS TM (Student Attendance Monitoring System) that consists of a server and a dedicated app. The students had to download the codes, which were generated by SAMS TM. The instructor had to scan the code using the app. The assessment of the system's early prototype's receptiveness revealed that both instructors and students agreed to utilize the app and a physical device in recording the attendance.

In addressing the need to check attendance of large group size not only in classes but also in events, Deugo (2015) developed a server-based system that allowed users to track the attendance using a mobile app and retrieve real-time Excel-based reports. It also let students generate their own codes through a web-based ID generator. Similar to the foregoing studies, the creation of the system was based on how production costs could be minimized using open source software and affordable hardware components.

In this study, a QR Code-based attendance system that utilizes mobile technology and Excel spreadsheet is proposed. This eliminates the need to use additional hardware and software components (e.g., server, database, and code generator), allowing instructors to experience convenience in monitoring attendance and providing students ease in checking their attendance records. This also removes the cost of developing an attendance system since the required components are readily available and can be installed in devices such as laptops and smartphones.

Research Objectives

This study aims to evaluate the acceptability of an attendance monitoring system that utilizes the QR Code. In particular, it seeks to address the following objectives:

1. To describe the configuration and implementation details of the system.
2. To evaluate the acceptability of the system in terms of its functionality, reliability, usability, efficiency, and maintainability.
3. To determine whether a significant difference exists between instructor' and students' perceptions of the system's acceptability.

Research Methodology

This study was carried out with a sample of 32 instructors and 98 college students at Bulacan State University - Meneses Campus during the academic year 2018-2019. The students were enrolled in Computer Engineering as a Discipline, which is a one-unit course; hence, they had to attend a one-hour class period per week. The course was chosen for this particular study because it covers relevant topics that introduce students to emerging computer-based technologies.

After obtaining the respondents' consent, the attendance monitoring system using QR Code was introduced to the students and instructors by the first and second authors. Each of the respondents was shown a piece of paper that has a printed QR Code and name (Last Name, First Name MI.). Using a designated smartphone, the code was scanned, resulting in the automatic export of the information contained in each code was to the Excel spreadsheet. The respondents were not only able to observe the process but also look at how the details were recorded. The details recorded in the spreadsheet include the students' full name, date, and time of attendance.

After the demonstration, the respondents were asked to answer a (paper-based) questionnaire by rating the level of acceptability of the system. A structured questionnaire was developed based on the prescribed standards of ISO/IEC 9126 that evaluates a project's software quality. Five criteria were incorporated in the survey questionnaire, namely functionality, reliability, usability, efficiency, and maintainability. Each criterion consists of three items or statements, which were rated on a 5-point Likert scale ranging from "highly unacceptable" to highly acceptable.

In comparing the survey responses of the instructors and the students, Welch's t-test was used due to the unequal sample sizes of this study. Unlike the independent samples t-test, Welch's t-test does not assume equal variance and sample size when comparing means between two independent

groups. The literature suggests that this test is more robust than the commonly used independent samples t-test when dealing with such assumptions (Derrick et al., 2017).

Results

A. Configuration and Implementation Details of Attendance Monitoring System

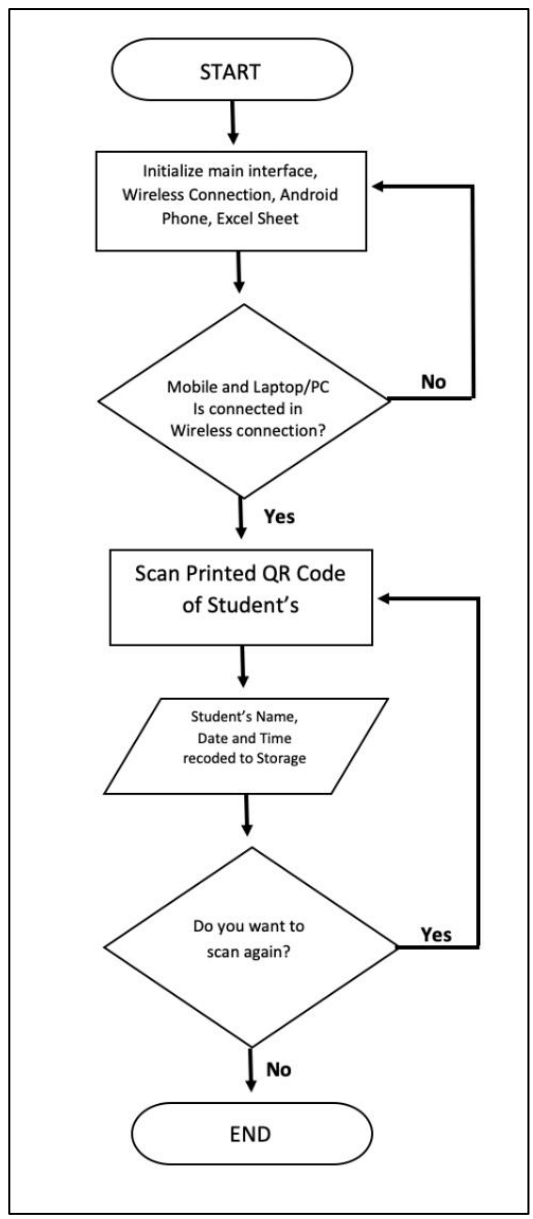

Figure 1 Configurations details of the attendance monitoring system

This study utilized an open-source software that served as the communication link between a scanner and the user's computer or laptop (Figure 1). The scanner was a mobile smartphone configured as a QR Code reader. It was connected to the main server (computer or laptop) that processes the data integrated into the QR Code. The open-source software used was a GitHub project called "barcode-to-pc-app." During the evaluation of the attendance monitoring system, the researchers used a mid-2009 MacBook Pro as the server computer and iPhone 6 mobile smartphone as the QR Code scanner. An attendance monitoring Excel file was also utilized for the data management, that is, for recording the attendance of the students.

In order to put the scans on the spreadsheet (in this case, the Excel file was used), an open-source application was downloaded as the server computer. The application can be found on https://barcodetopc.com/#download-server. The web page offers three versions of the application, .EXE for Windows, .DMG for Mac OSX, and .APPIMAGE for Linux Distros. After downloading and installing the .DMG version, which was compatible with Mac OSX 10.13 El Capitan, the next step was to download the smartphone application found in the Apple Store. The application is listed as "Barcode to PC: Wi-Fi scanner" in the App Store.

Users could either connect both the computer and the smartphone to the same Wi-Fi router or configure the smartphone as a dedicated hotspot and then connect it to the computer using the said hotspot. Connecting the devices to the same wireless router allows for the automatic linking of and opening of applications in both devices. However, in the absence of a wireless router, the smartphone's Wi-Fi hotspot could be used.

By setting the iPhone's personal hotspot, the MacBook Pro connected directly to the smartphone's network. In order to use the smartphone as a QR Code scanner, the server was required to be added manually. There were two ways of adding the server manually. The first was through the use of the QR Code displayed by the server. Steps are given below:

1. Open the server (Barcode to PC application on the laptop).
2. Click Info, and the connected QR Code should appear.
3. Open the app (Barcode to PC: Wi-Fi scanner on the smartphone).
4. Open the menu and tap "Select server."
5. Tap the scan icon [ ] and scan the QR Code displayed on the computer.

The other method was done by manually inputting the computer's IP address, which was done through the following steps:

1. Open the server.
2. Open the menu and tap "Select server."
3. Tap the add icon + and type the IP address of the server.

After successfully linking the devices (computer as the server and smartphone as the QR Code Scanner), the Attendance Monitoring Excel file was opened. The cursor was positioned on the 'Names' column. The QR Code was scanned by tapping the camera icon in the smartphone app. Every time a QR Code was scanned, the following details were recorded to the attendance monitoring file: date and time of arrival and full name. With the keyboard emulation feature of the server application, each scanned QR Code data was typed in the cursor position.

B. Instructors' Perceptions on the Acceptability of Attendance Monitoring System

The instructors rated the attendance monitoring system's level of acceptability. Table 1 shows that all of the items were evaluated as "highly acceptable." The item concerning the system's capability of changing or modifying the processes included in checking the attendance gained the highest mean rating (M = 4.84). In contrast, the item that refers to the capacity of the system to be error-free and to process the accurate checking of attendance received the lowest mean rating (M = 4.59).

Table 1 Frequency distribution and weighted responses of the instructors' acceptability of attendance monitoring system

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
<u>Functionality</u>							
1. The system is fully capable of checking attendance.	22 (68.8)	10 (31.3)	-	-	-	4.69	Highly Acceptable
2. All the required procedures for checking the attendance are accurate and functional.	21 (65.6)	11 (34.4)	-	-	-	4.66	Highly Acceptable
3. The system is capable of securing students' data or information, and only authorized personnel (instructor) can access such data.	21 (65.6)	11 (34.4)	-	-	-	4.66	Highly Acceptable

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
Reliability							
1. The system can be used anytime for checking the attendance with minimal or no errors in terms of its functionality.	21 (65.6)	10 (31.3)	1 (3.1)	-	-	4.63	Highly Acceptable
2. The system is free from errors and can process the checking of attendance accurately.	21 (65.6)	9 (28.1)	2 (6.3)	-	-	4.59	Highly Acceptable
3. The system can maintain an acceptable level of performance over a long period of use.	22 (68.8)	9 (28.1)	1 (3.1)	-	-	4.66	Highly Acceptable
Usability							
1. The system is user-friendly and easy to use.	25 (78.1)	5 (15.6)	2 (6.3)	-	-	4.72	Highly Acceptable
2. The system's interface in Excel spreadsheet can be viewed and accessed easily, clearly, and accurately.	25 (78.1)	7 (21.9)	-	-	-	4.78	Highly Acceptable
3. The system is well-organized and fully considers the needs of the user.	23 (71.9)	9 (28.1)	-	-	-	4.72	Highly Acceptable
Efficiency							
1. The system is capable of performing in a consistent manner during its operation.	21 (65.6)	11 (34.4)	-	-	-	4.66	Highly Acceptable
2. The system responds quickly to the action (scanning the code) carried out by the user.	25 (78.1)	7 (21.9)	-	-	-	4.78	Highly Acceptable

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
3. The system is capable of providing an appropriate response to the action (scanning the code) taken by the user.	22 (68.8)	10 (31.3)	-	-	-	4.69	Highly Acceptable
<u>Maintainability</u>							
1. The system is capable of storing students' attendance details for maintenance purposes.	22 (68.8)	10 (31.3)	-	-	-	4.69	Highly Acceptable
2. The system can be easily configured or arranged to address the needs of the user.	21 (65.6)	11 (34.4)	-	-	-	4.66	Highly Acceptable
3. The system is capable of changing or modifying the processes included in checking the attendance.	27 (84.4)	5 (15.6)	-	-	-	4.84	Highly Acceptable

All (100%) reported that the system was either highly acceptable or acceptable in terms of its capability to check the attendance. They also responded "highly acceptable" or "acceptable" to items concerning the accurate and functional procedures for checking the attendance (100%) and security and accessibility of the students' data or information (100%).

Nearly all of the respondents rated the reliability of the system as either highly acceptable or acceptable. The positive ratings were consistent across the three items concerning its capabilities to be used anytime for checking the attendance with minimal or no errors (96.9%), to be free from errors while checking the attendance (93.7%), and to be maintained in an acceptable performance for a long time of usage (96.9%).

With regard to its usability, virtually all of the respondents (93.7%) perceived the system to be highly acceptable or acceptable in terms of its user-friendly and easy-to-use characteristics. All of them regarded it as a highly acceptable or acceptable system in terms of viewing and accessing its Excel interface (100%) and considering the user's need through its well-organized features (100%).

The two remaining indicators, efficiency, and maintainability gained positive levels of acceptability. This is reflected in how they rated the capabilities of the system in terms of efficiency as

highly acceptable or acceptable. The same goes for the highly acceptable or acceptable ratings given to the capabilities offered by the system as regards maintainability.

C. Students' Perceptions of the Acceptability of Attendance Monitoring System

The students were asked to rate the attendance monitoring system's level of acceptability. As shown in Table 2, the majority of the responses were either "highly acceptable" or "acceptable." Thirteen out of 15 items or statements were perceived to be "acceptable" by the respondents. The highest level of acceptability was recorded in the item concerning the system's user-friendliness and ease of use (M = 4.70) while the lowest level of acceptability was found in the statement pertaining to the system's capacities to be free from errors and to process the accurate checking of attendance (M = 3.90).

Table 2 Frequency distribution and weighted responses of the students' acceptability of attendance monitoring system

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
<u>Functionality</u>							
1. The system is fully capable of checking attendance.	59 (60.2)	33 (33.7)	4 (4.1)	2 (2.0)	-	4.52	Highly Acceptable
2. All the required procedures for checking the attendance are accurate and functional.	46 (46.9)	37 (37.8)	14 (14.3)	1 (1.0)	-	4.30	Acceptable
3. The system is capable of securing students' data or information, and only authorized personnel (instructor) can access such data.	44 (44.9)	36 (36.7)	16 (16.3)	2 (2.0)	-	4.24	Acceptable

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
Reliability							
1. The system can be used anytime for checking the attendance with minimal or no errors in terms of its functionality.	36 (36.7)	39 (39.8)	23 (23.5)	-	-	4.13	Acceptable
2. The system is free from errors and can process the checking of attendance accurately.	24 (24.5)	43 (43.9)	28 (28.6)	3 (3.1)	-	3.90	Acceptable
3. The system can maintain an acceptable level of performance over a long period of use.	34 (34.7)	42 (42.9)	19 (19.4)	1 (1.0)	2 (2.0)	4.07	Acceptable
Usability							
1. The system is user-friendly and easy to use.	73 (74.5)	21 (21.4)	4 (4.1)	-	-	4.70	Highly Acceptable
2. The system's interface in Excel spreadsheet can be viewed and accessed easily, clearly, and accurately.	54 (55.1)	33 (33.7)	10 (10.2)	1 (1.0)	-	4.43	Acceptable
3. The system is well-organized and fully considers the needs of the user.	46 (46.9)	40 (40.8)	12 (12.2)	-	-	4.35	Acceptable
Efficiency							
1. The system is capable of performing in a consistent manner during its operation.	39 (39.8)	45 (45.9)	14 (14.3)	-	-	4.26	Acceptable
2. The system responds quickly to the action (scanning the code) carried out by the user.	42 (42.9)	38 (38.8)	17 (17.3)	1 (1.0)	-	4.23	Acceptable

Item	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	Mean	Verbal Interpretation
3. The system is capable of providing an appropriate response to the action (scanning the code) taken by the user.	47 (48.0)	38 (38.8)	12 (12.2)	1 (1.0)	-	4.34	Acceptable
Maintainability							
1. The system is capable of storing students' attendance details for maintenance purposes.	53 (54.1)	33 (33.7)	12 (12.2)	-	-	4.42	Acceptable
2. The system can be easily configured or arranged to address the needs of the user.	47 (48.0)	38 (38.8)	13 (13.3)	-	-	4.35	Acceptable
3. The system is capable of changing or modifying the processes included in checking the attendance.	47 (48.0)	34 (34.7)	17 (17.3)	-	-	4.31	Acceptable

In terms of functionality, most (93.9%) of them indicated that the system was either highly acceptable or acceptable in terms of storing students' attendance details for maintenance. A vast majority responded "highly acceptable" or "acceptable" to items pertaining to the accurate and functional procedures for checking the attendance (84.7%) and secure capability of accessing students' details (81.6%).

More than three quarters (76.5%) of the respondents expressed the belief that the system's reliability of being free from errors and accurately processing the attendance was either highly acceptable or acceptable. A large majority of the respondents perceived that the system is free from errors in processing the attendance (68.2%) and can maintain an acceptable performance level even in the long run (77.6%).

As regards usability, nearly all of the respondents (95.9%) either highly accepted or accepted the user-friendly and easy-to-use features of the system. The positive ratings of acceptability were consistent across the two items concerning the easy viewing of and access to the system's Excel interface (88.8%) and well-organized features that fully consider the user's needs (87.7%).

The system was also either highly acceptable or acceptable to a vast majority of the respondents with regard to its efficiency or capability to perform operations in a consistent manner (85.7%) and responding quickly to the act of scanning the code (81.7%). A large majority of them (86.8%) highly accepted or accepted the system's feature of providing the appropriate response to such action.

As regards the system's maintainability, a strong majority of the respondents reported the system's capabilities of storing students' attendance for maintenance purposes (87.8%) and being easily configured to address the user's needs (86.8%) as highly acceptable or acceptable. The system was also regarded by a large majority of respondents (82.7%) as capable of changing or modifying the processes included in checking the attendance.

D. Comparison of the Instructors' and Students' Perceptions on the Acceptability of Attendance Monitoring System

Table 3 indicates that the respondents' ratings of the system's acceptability varied by group. In terms of functionality, there was a significant difference in the rating, $t(73) = 3.38$, $p = .001$. The results show that the instructors ($M = 4.67$, $SD = 0.41$) had higher level of acceptability than that of the students ($M = 4.36$, $SD = 0.56$).

Results also showed a significant difference in the perceptions of both groups about the system's reliability, $t(70) = 5.26$, $p < .000$. The instructors ($M = 4.63$, $SD = 0.51$) rated this criterion higher than the students ($M = 4.03$, $SD = 0.67$).

With regard to the usability of the system, there was also a significant difference, $t(68) = 2.60$, $p = .011$. The instructors ($M = 4.74$, $SD = 0.43$) exhibited a higher level of acceptability than the students ($M = 4.49$, $SD = 0.56$).

Table 3 Results of t-test and descriptive statistics

Criterion / Variable	Group				t	df	Sig. Value
	Instructors (N = 32)		Students (N = 98)				
	M	SD	M	SD			
Functionality	4.67	0.41	4.36	0.56	3.38	73	.001
Reliability	4.63	0.51	4.03	0.67	5.26	70	.000
Usability	4.74	0.43	4.49	0.56	2.60	68	.011
Efficiency	4.71	0.39	4.28	0.63	4.58	85	.000
Maintainability	4.72	0.38	4.36	0.62	4.03	87	.000

In comparing the means of the two groups as regards the system's efficiency, the results found a significant difference, $t(85) = 4.58$, $p < .000$. The instructors ($M = 4.71$, $SD = 0.39$) reported a higher level of acceptability as compared to that of the students ($M = 4.28$, $SD = 0.63$).

Lastly, the t-test analysis concerning the maintainability of the system resulted in a significant difference, $t(87) = 4.03$, $p < .000$. The instructors ($M = 4.72$, $SD = 0.38$). perceived the system to be more acceptable than the students ($M = 4.36$, $SD = 0.62$).

Discussion

This research has shown that an attendance monitoring system using QR Code can be developed using existing and readily available software and hardware components. The wide availability of smartphones has made it even more convenient for users to maximize the use of QR code in creating a system that automatically checks students' attendance. Specific phones' features, such as built-in cameras and support for a variety of mobile apps, aid in the integration of QR code into an attendance monitoring system (Cho & Bae, 2014).

The high ratings given by both instructors and students indicate that the system is viewed as functional, reliable, usable, efficient, and maintainable. The perceived clear-cut and secure approach to taking attendance contributes to the system's functionality. With regard to its reliability, the minimal errors encountered while utilizing the system is deemed to result in long-term usage. The system is considered usable as far as its user-friendly, accessible, and organized interface is concerned. It is also regarded as an efficient system due to its capability of carrying out prompt and proper responses in a consistent manner. Lastly, in terms of maintainability, it is viewed as a system with components that can be easily modified.

The evaluation results indicate that the attendance monitoring system can be applied in a classroom-based setting. Compared to the traditional mechanism of recording attendance, the QR code-based attendance monitoring tool contains features that offer convenience, provide a faster way of getting data, and minimize errors (Koh et al., 2017; Deugo, 2015). A key feature, which makes the system a good alternative, is the use of an Excel spreadsheet. This only means that a paperless mechanism is at place to collect attendance-related data, which can then be easily saved and backed up to prevent data loss and allow for immediate retrieval and calculation (Baban, 2014).

Since the attendance monitoring system does not require the integration of additional hardware and software components, users would largely benefit from the minimal cost associated with its development and implementation. This is also given emphasis by Jadhav et al. (2018) when they

developed an Android-based attendance system that can run on instructors' existing devices. Although there is a need to utilize at least one dedicated device (i.e., a smartphone) to scan the code, the feasibility of working on such a system is highly possible. Rahni et al. (2015) noted that the cost-effectiveness of an attendance system could reasonably be achieved due to high levels of ownership and usage of smartphones. A case in point is that in the Philippines, more than half (53%) of adults use, own, or share smart phones, and the majority (65%) of them have access to the Internet (Pew Research Center, 2019).

With the foregoing statements, an attendance monitoring system characterized by its cost-effectiveness and simplicity can be considered as an effective tool for monitoring student's attendance. This is particularly applicable to a large class size in which instructors need to spend additional time to get attendance. In this regard, the system is more likely to benefit instructors, which can be explained by their higher level of acceptability of the system as compared to that of the students. By automating the process of taking attendance, the instructors and their students would spend most of their class time engaging in lectures and discussions (Masalha & Hirzallah, 2014).

Moreover, the system can store details that are complete and more accurate (i.e., full name, date, and time of attendance) than those that are captured through the conventional attendance monitoring system. While an automated system's performance may be limited by an intermittent Internet connection, the high level of accuracy of the data that can be generated by this system cannot be discounted (Koh et al., 2017). This system's capability, however, still needs to be improved since the lowest mean rating is recorded in the item concerning its capacities to be error-free and to carry out an accurate process of checking the attendance.

Conclusions and Recommendations

Overall, the QR Code-based attendance monitoring system offers features that can be suitably utilized in a higher education setting. Given the simplified processes employed in its configuration and implementation, the system is likely to benefit users who consider functionality, reliability, usability, efficiency, and maintainability as the foremost criteria in maximizing its usage. The results of this study indicate that the system can be adopted and utilized as a viable means for checking students' attendance on the campus. In particular, the positive feedback gained from the evaluation of its potential users can be used to improve its functionalities.

Future research may consider storing the information concerning attendance details in a database server so that they can be protected and secured against loss. Since attendance is regarded as a crucial component of class performance, such database information can be utilized by instructors in

providing their students with regular feedback on their class standing. The availability of attendance-related data would allow for the identification of students who incur excessive absenteeism and, thus, lead to the formulation of necessary mechanisms to help such students get back on track.

Developers may also consider working on the creation of a stand-alone system that does not only monitor attendance but also track pertinent information concerning overall class performance. This system can be connected to a cloud server so that real-time data can be generated and used not only by faculty members but also by school counselors. In doing so, assessment of a student's class performance can be easily done, providing baseline information for crafting targeted interventions, especially if the student is considered at risk due to low academic performance.

In the context of learning, a variety of resource materials can be embedded in the QR Code to provide all students, regardless of their attendance status, the opportunity to maximize their learning even outside the classroom. Instructors can post QR Codes that would connect their students directly to additional instructional materials such as video clips, podcasts, tutorial resources, and multimedia contents. In doing so, through this innovative way of doing instructional scaffolding, they can increase their students' engagement with learning. Additional information, which may also be stored in the QR Code, is missed coursework (e.g., assignment, examination, recitation, and project), giving students a chance to make arrangements with their instructors regarding its completion and deadline. It is likely that the integration of these technology-based learning interventions, which are supported by QR Code technology, could result in positive academic outcomes.

References

Al-Shammari, Z. N. (2016). Enhancing higher education student attendance through classroom management. *Cogent Education,* 3(1), 1-11. doi:10.1080/2331186x.2016.1210488

Asare, I. T., & Asare, D. (2015). The effective use of Quick Response (QR) Code as a marketing tool. *International Journal of Education and Social Science*, 2(12), 67–73. Retrieved from http://www.ijessnet.com

Aulya, R., Hindersah, H., Prihatmanto, A. S., & Rhee, K. H. (2016). An authenticated passengers based on dynamic QR Code for Bandung Smart Transportation Systems. *Proceedings of the 6th International Annual Engineering Seminar, Indonesia* (pp. 23-27). doi:10.1109/inaes.2016.7821900

Baban, M. H. (2014). Attendance checking system using quick response code for students at the University of Sulaimaniyah. *Journal of Mathematics and Computer Science,* 10(3), 189-198. doi:10.22436/jmcs.010.03.04

Cho, D. J., & Bae, M. Y. (2014). A study on development of OTIP System using QR Code based on Smartphone. *International Journal of Multimedia and Ubiquitous Engineering,* 9(10), 261-270. doi:10.14257/ijmue.2014.9.10.25

Credé, M., Roch, S. G., & Kieszczynka, U. M. (2010). Class attendance in college: A meta-analytic review of the relationship of class attendance with grades and student characteristics. *Review of Educational Research,* 80(2), 272-295. doi:10.3102/0034654310362998

Czuszynski, K., & Ruminski, J. (2014). Interaction with medical data using QR-codes. *Proceedings of the 7th International Conference on Human System Interactions, Portugal* (pp. 182-187). doi: 10.1109/HSI.2014.6860471

Denso ADC. (2012). *QR Code essentials.* Retrieved from https://delivr.com/resources/files/1058/DENSO_ADC_QR_Code_White_Paper.pdf

Derrick, B., Russ, B., Toher, D., & White, P. (2017). Test statistics for the comparison of means for two samples that include both paired and independent observations. *Journal of Modern Applied Statistical Methods,* 16(1), 137-157. doi:10.22237/jmasm/1493597280

Deugo, D. (2015). Using QR-codes for attendance tracking. Paper Presented at *the 2015 World Congress in Computer Science, Computer Engineering, and Applied Computing, Las Vegas, NV.* Retrieved from http://worldcomp-proceedings.com/proc/p2015/FEC2508.pdf

Hendry, M.R.M., Rahman, M.N.A., & Seyal, A.H. (2017). Smart attendance system applying QR Code. Paper presented at *the 12th International Conference on Latest Trends in Engineering and Technology, Kuala Lumpur, Malaysia*. Retrieved from http://iieng.org/images/proceedings_pdf/E0517002.pdf

Hossain, M.S, Zhou, X., & Rahman, M.F. (2018). Examining the impact of QR Codes on purchase intention and customer satisfaction on the basis of perceived flow. *International Journal Engineering Business Management,* 10, 1-11. doi:10.1177/1847979018812323

Jadhav, S., Gagare, A., Gunjal, P., & Jagtap, V. (2018). Android based smart attendance system using QR Code. *International Journal of Innovative Research in Computer and Communication Engineering,* 6(3), 2458-2464. doi:10.15680/IJIRCCE.2018.0603126

Koh, K. C., et al. (2017). Medical students' perception on the use of QR Code versus traditional pen-and-paper as an attendance record tool in medical School. *Journal of Mobile Technology in Medicine,* 6(3), 2-6. doi:10.7309/jmtm.6.3.2

Masalha, F., & Hirzallah, N. (2014). A student attendance system using QR Code. *International Journal of Advanced Computer Science and Applications*, 5(3), 75-79. doi:10.14569/IJACSA.2014.050310

Pew Research Center. (2019). *Mobile connectivity in emerging economies.* Retrieved from https://www.pewresearch.org/internet/wp-content/uploads/sites/9/2019/03/PI_2019.03.07_Mobile-Connectivity_FINAL.pdf

Rahni, A.A.A., Zainal, N., Zainal Adna, M.F., Othman, N.E., & Bukhori, M.F. (2015). Development of the online student attendance monitoring based on QR-Codes and mobile devices. *Journal of Engineering Science and Technology,* 10, 28-40.