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QR Code and Fingerprint Systems for University Examinations Management

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ABSTRACT

Several universities and other higher learning institutions throughout Tanzania use paper-based attendance systems and the old file system for recording student attendance during university examinations. The paper-based attendance system has several impediments, including chances of impersonation and the possibility of doing an examination without meeting requirements. Moreover, hard copy work is tedious and prone to vandalism or data loss due to paper misplacement or destruction. Several electronic general-purpose attendance systems and fewer attendance systems are engineered for university attendance management. However, university examination regulations conflict with those systems. Henceforth, there is a gap in their applicability and adaptability. This study developed a QR code and fingerprint attendance prototype that resolves the shortcomings of existing electronic attendance systems. Fingerprints determined students' identity during entry and exit sessions, while the QR code determined students' examination answer booklet IDs during exit sessions. To assess the effectiveness of the attendance prototype, a sample of 120 students and 20 invigilators experimented with the prototype. The study findings show that the QR code and fingerprint systems are applicable and effective for managing university examination attendance in Tanzania. In addition, the study provides areas for future research.

Keywords: Attendance system, Examination Management, Fingerprint, QR code.

1 INTRODUCTION

Higher Learning Institutions (HLIs) throughout Tanzania, including universities, operate semester-wise (half-yearly). The students sit for the semester examinations at the end of each semester. However, the students supplement (resit) for failed courses at a time determined by a specific institution. HLIs require students to register their attendance as a sign and evidence of being present for each examination. Tanzania had her first HLI in 1961. After that, the number of HLIs increased significantly. Despite the increased number of HLI, the paper-based attendance system persists. The paper-based attendance system has proven stressful for students and lecturers [1]. The integrity of a paper-based attendance system may easily be compromised since there is a chance for students to sign the attendance sheets for their absent colleagues, thereby creating a loophole for impersonation [2]. The paper-based attendance system has a low possibility of verifying examination prerequisites like coursework and payments. Moreover, hard copy work is tedious and prone to vandalism or data loss due to paper misplacement or destruction.

Several automated attendance systems have been developed to overcome the challenges associated with the paper-based attendance system. Popular methodologies for automated attendance systems are barcode [3,4], QR code [5,6] and fingerprint [1,2,7]. Other methodologies include iris scan and face recognition.

Most automated attendance systems proved to be faster than the paper-based attendance system. However, they skip recording the examination answer booklet IDs. The existing automated attendance systems also conflict with the examination regulations and guidelines. Moreover, the existing automated attendance system mainly focuses on

attendance recording while neglecting prerequisites like coursework and payment. The study, thus, developed an examination attendance prototype that resolves the limitations of existing automated systems. The developed prototype utilizes fingerprints for students' identification and QR codes for examination answer script (booklet) identification. People have been using fingerprints for recognition because of their simplicity and accuracy[8]. Moreover, the fingerprint is in favor of variables like accuracy, performance, uniqueness, permanence, universality, security, collectability, cost, and user acceptance that determine the strength of the biometrics [9-11]. The QR code is a matrix barcode which can store alphanumeric characters. QR code is prevalent due to its ability to read quickly and to hold large amounts of information. The QR code and fingerprint attendance prototype assessment shows that the prototype performs better than the paper-based attendance system.

2 RELATED LITERATURE

2.1 QR Code Overview and Emerging Application

QR code is a matrix barcode that stores several data types such as numeric, alphabetical, kanji, kana, hiragana, symbols, binary, and control codes [6]. The ability of QR codes to hold multiple data types allows developers to use them for many applications [5]. QR codes have recently become predominant for payments and other e-commerce and logistical activities due to their quick and accurate identification [12]. For instance, Vodacom Tanzania enhanced its mobile money merchant payment solution (M-PESA) by adding QR codes that substitute for keying in till numbers in retail stores. Moreover, in the health industry, the QR code is suggested as a private data exchange method between patients and laboratories or other parties [13]. This study, therefore, chose to use the QR code due to its ability to encrypt and scan large amounts of information.

2.2 Fingerprint Overview, Trends, and Applications

A fingerprint is among biometrics that enable personal recognition based on physiological characteristics [14]. An ideal biometric is assessed on performance, acceptability, uniqueness, permanence, universality, and collectability [11]. Fingerprints have been used for centuries as direct contact with materials like clay or inked fingers on paper. Technology advancement enables the electronic acquisition of fingerprints on the surface of a scanner in the form of 2D or 3D images. Fingerprints are used in different contexts, including biometric security, attendance management, crime investigation, and identifying unknown deceased. Fingerprints are so unique that identical twins have different fingerprints [15].

2.3 Paper-based Attendance Systems

Most universities use paper-based attendance systems to keep records of students present in examination venues. The attendance signing process usually takes place twice in a paper-based attendance system: immediately after the start of the examination and during the submission of the examination answer script (booklet). The paper-based attendance system requires invigilators to verify and authenticate students to participate in the examination (typically at the entrance). Students are, therefore, needed to carry their IDs for verification purposes. This method of verification is known as token-based [7]. The paper-based attendance system is reported to be an arduous task and time-consuming [4].

2.4 Electronic Systems for University Examinations Attendance

An electronic university attendance system is a combination of hardware and software developed for students' attendance management [16]. There has been little literature on electronic university examination attendance management. The literature includes the Mobile Barcode Based Examination Attendance System (MBEAS) [3]. The MBEAS is preconfigured with subjects, examination halls, and schedules during examination sessions. Invigilators scan students' IDs, and students' information are sent directly to the database server. Another piece of literature is A Wireless Sensor Network for Examination Attendance Management System that collects, stores, tracks and transfers examination attendance data to a host computer for analysis and report generation [17]. The system employs fingerprint recognition for obtaining students' examination attendance, course registration, and tuition fee clearance. Despite little research on university examination attendance management, the literature review identified several class

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attendance systems, such as QR Class [5], Educational Time and Attendance Management System (EduTAMS) [18], Online Biometric-enabled Class Attendance Register System (OBCARS) [2], and Smart Attendance Management System (SAMSYS) [1]. Both literatures show that electronic attendance systems perform better than paper-based attendance systems. For instance, QR Class reduces attendance processing time by 93.14% compared to paper-based. Similarly, the ratio of the attendance signing time of EduTAMS, OBCARS, and SAMSYS against the paper-based attendance system are (6.65: 23.68), (8.7: 22.6), and (3.79: 17.83) respectively. Despite the better performance, existing electronic attendance systems have several limitations.

2.5 Limitations of Existing Electronic Attendance Systems

First, using mobile phones in the examination rooms is illegal for students in most universities in Tanzania. The QR Class and other systems that require students to scan QR codes with their registered mobile phones violate examination regulations. Therefore, assessing, adopting, or implementing a similar attendance system in Tanzania would be impractical.

Second, barcodes and QR codes for students' identification leave behind impersonation loopholes since ID cards and mobile phones can be transferable from one student to another. As a result, QR Class and Mobile Barcode Based Examinations Attendance System are inadequate for impersonation prevention.

Third, most existing literature focuses on students' identification and attendance recording while neglecting examination prerequisites like coursework and payment.

Fourth, existing literature didn't pay more attention to guaranteeing students are in the correct examination venues, particularly when large classes are split into multiple venues. Uneven student distribution to examination venues can result in issues including improper examination venue setup, students missing question papers or examination answer booklets, and unnecessary movement during examinations, as invigilators may instruct students to shift to other examination venues.

Fifth, existing systems do not have a mechanism for recording booklet IDs. Two or more students may mistakenly write the same examination number on their answer booklets. In such a case, only the booklet ID could link the booklet and the student.

From these viewpoints, the study developed a QR code and Fingerprint attendance prototype for university examination management. QR code is for identification of booklet IDs, and fingerprint is for identification of students. The study further assesses the performance of the developed prototype against a paper-based attendance system.

3 METHODOLOGY

The research adopted an experimental design to assess the effectiveness of QR code and Fingerprint systems against the paper-based attendance system for university examinations management. The research paper developed a QR code and Fingerprint attendance prototype to fit the examination regulations of most universities in Tanzania by extracting functional and non-functional requirements from prospectuses, regulations, and existing literature. The prototype consists of hardware and software components for recording student attendance and providing appropriate success or error notifications. The experimentation setup utilizes eight (8) days involving twenty (20) invigilators and 30 students. However, each student registered four different fingerprints, totaling one hundred twenty (120) students. Additionally, forty-three (43) courses were registered for experiments, with a maximum enrollment of eight courses per student. During the first three (3) days, the study planned to experiment in both attendance systems to perform two hundred forty (240) experiments using sixteen (16) courses for each attendance system. The remaining five (5) days were for QR code and fingerprint attendance systems only, such that three hundred sixteen (316) experiments were performed on twenty-seven (27) courses to check the reliability of the system in authenticating and managing students attendance. Therefore, the study conducted two hundred forty (240) experiments for paper-based attendance system and five hundred fifty-six (556) experiments for QR code and fingerprint attendance system.

The study further uses a self-administered structured questionnaire and observation to confirm the validity and reliability of the findings and conclusions deduced. Questionnaires were used to examine the correlation between

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experimental results and participant comments. The researcher observed the experimentation process to ensure the quality of data gained. Table 1 provides a summary of the research instruments used for obtaining data.

Table 1: Research instruments versus respondent groups

Research Instrument	Respondent Group	No. Respondents
Experiment	Students	120
Questionnaire	Invigilators	20
Observation	Researcher	

4 THE UNIVERSITY EXAMINATIONS ATTENDANCE MANAGEMENT PROTOTYPE

The prototype is composed of hardware and software. In addition, the prototype stores data in a relational database. The hardware components include a microcontroller (Arduino Mega 2560), fingerprint module (JM101), QR code engine (MG 2DE200), LCD (1604), 4 x 4 membrane switch keypad, LEDs, buzzer, breadboard, and resistors.

The software part of the attendance prototype consists of three loose-coupled applications: the embedded application that controls the microcontroller, the standalone application that communicates serially with the microcontroller, and the web application that lecturers and management access to generate reports. Logically, each application has its own requirements and runtime environment, yet they are all interdependent. Table 2 lists the requirements of a prototype. Furthermore, Table 3 provides requirements descriptions. A general program structure is shown in Figure 1, and the logical flow of the prototype is shown in Figures 2, 3, and 4.

Table 2: System requirements

Req. ID	Requirement Title	Target Users	Priority
REQ-F-00	Setting examination venue	Invigilators	M
REQ-F-01	Setting examination session (entry/exit)	Invigilators	M
REQ-F-02	Communicating with other university sub-systems	-	M
REQ-F-03	Verification of student's identity using fingerprint	Students	M
REQ-F-04	Verification of student's coursework	Students	S
REQ-F-05	Verification of student's payments	Students	M
REQ-F-06	Verification of student's class attendance	Students	W
REQ-F-07	Verification of examinations venues	Students	S
REQ-F-08	Verification of signing in time	Students	M
REQ-F-09	Verification of signing out time	Students	M
REQ-F-10	Recording examination answer booklet ID using QR code	Students	M
REQ-F-11	Generate templates for university examinations results	Lecturers	S
REQ-F-12	Generate list of absent students	Management	S
REQ-F-13	Generate list of absconded students	Management	S
REQ-N-00	Refraining from using cell phones	Students	M

Table 3: Requirements descriptions

Req. ID	Description
REQ-F-00	Before beginning to record students' attendance, the invigilator must set an examination venue, and that venue must have examinations per the timetable.
REQ-F-01	Before beginning to record students' attendance and after setting an examination venue, the invigilator must set the examination session (entry/exit).
REQ-F-02	Because the system relies heavily on data from other university systems, such as admissions, finance, and academics, it must communicate with them in real-time.
REQ-F-03	The identity of the student must be verified, and the correct student's information must be recorded.
REQ-F-04	Only students with complete coursework should sit for an examination
REQ-F-05	Only students who completed the required fees should sit for an examination
REQ-F-06	The student with at least 80% of class attendance are eligible for examination
REQ-F-07	Students should be denied to enter examinations venues that they have not been allocated to at the

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	specified time.
REQ-F-08	Thirty (30) minutes before or after commencement of any examination, no candidates shall be allowed into the examination's venues.
REQ-F-09	Candidates must not leave the examination room before the lapse of at least one hour.
REQ-F-10	The examination answer booklet's ID number must be recorded and assigned to the students who used it.
REQ-F-11	The system should generate a template for university examinations results that only include students who sat for the particular examination.
REQ-F-12	The system should be able to generate a list of absent students as soon as the scheduled examination is completed.
REQ-F-13	The system should be able to generate a list of absconded students as soon as all scheduled examinations for a given program are completed.
REQ-N-00	The system methodology must refrain students from using cell phones during examination because it is prohibited.

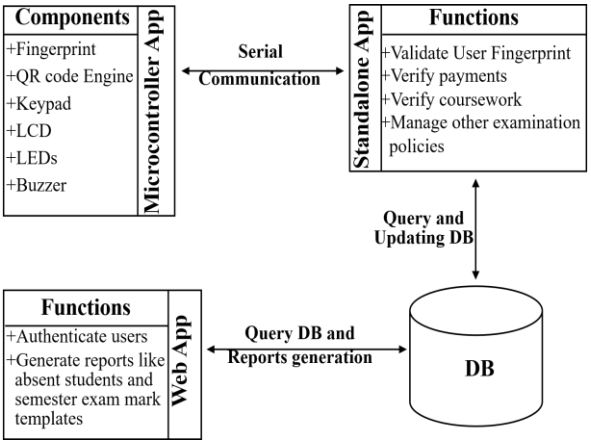

Figure 1: A general program structure

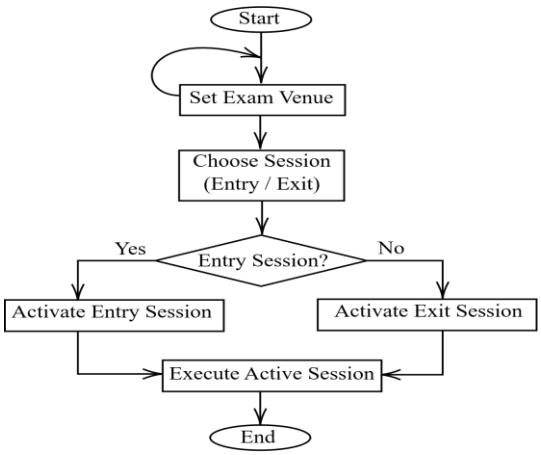

Figure 2: Initial program setting

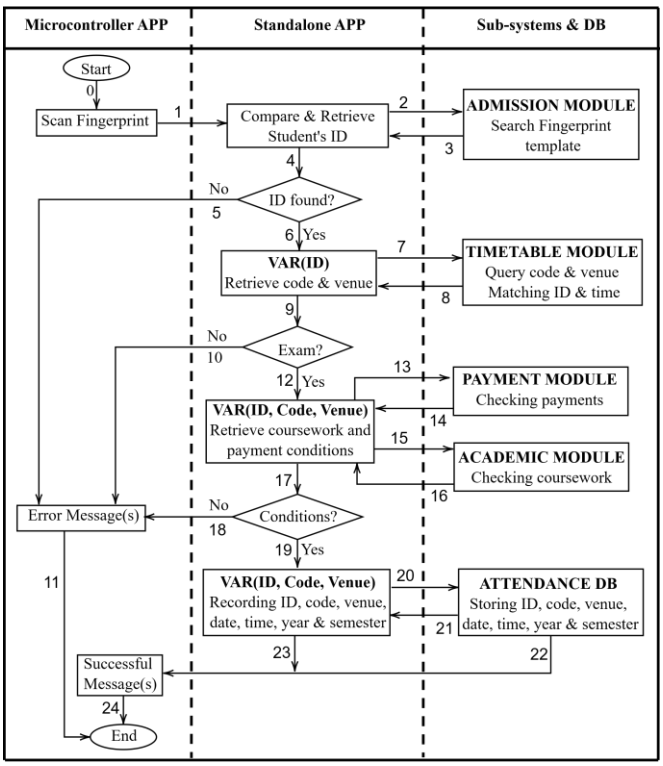

Figure 3: Examination entry session

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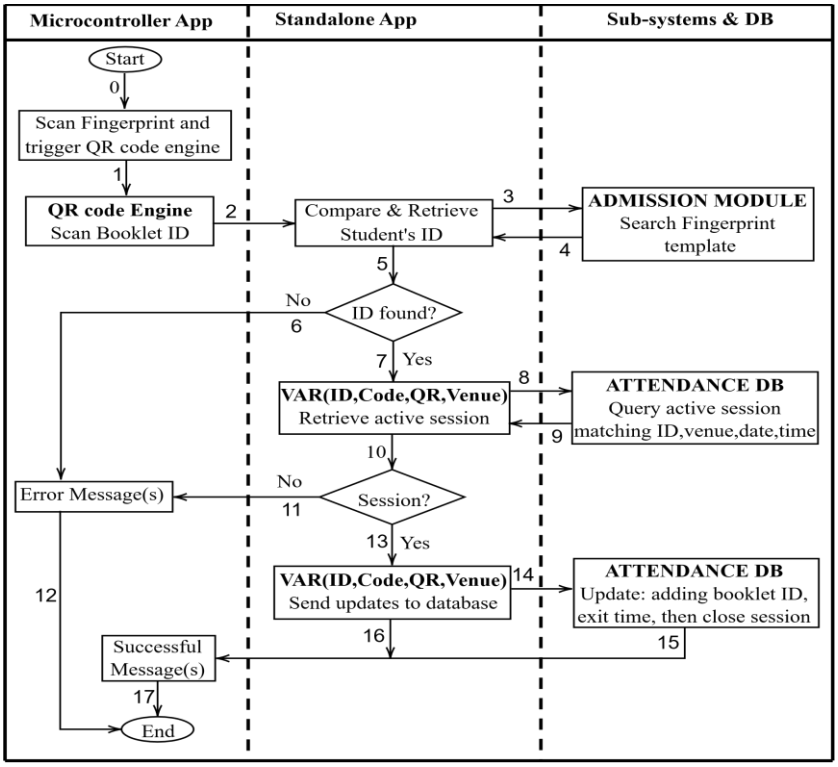

Figure 4: Examination exit session

5 RESULTS

The study group results in three (3) classes. First, the experimental results of a paper-based attendance system for benchmarking. Second, experimental results of the QR code and fingerprint attendance prototype for performance assessment. Third, Feedback from respondents for control and validation of experimental results

5.1 Paper-based Attendance System

For benchmarking purposes, the study assessed the performance of a paper-based attendance system based on four (4) variables: time utilization, payment verification, coursework verification, and examination venue verification. For each variable, the benchmark was set for comparison with the fingerprint and QR code attendance system.

A: Time Utilization

Paper-based signing-in time is equated to 54.82 seconds per student. Table 4 shows the readings.

Table 4: Checking time for examination entrance pass

	Day	IDs Checking (sec)						Attendance Writing (sec)													
		7	8	9	10	11	12	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Occurrence	01	4	8	6	7	4	1	4	1	2	4	3	2	2	4	3	2	1	1	1	0
	02	2	7	6	8	5	2	1	2	2	3	3	4	3	3	1	3	2	2	0	1
	03	2	6	8	7	5	2	2	2	2	2	4	3	2	3	4	3	2	1	0	0

Signing InTime = IDs Checking $Time_{(avg)}$ + Attendance $WritingTime_{(avg)}$

$$= \forall date \frac{\sum_{t7}^{t12}(occurance\ .\ time_t}{N_{days}\ .\ N_{students}} + \forall date \frac{\sum_{t40}^{t53}(occurance\ .\ time_t}{N_{days}\ .\ N_{students}}$$

$$= \frac{(4x7+\cdots)+(2x7+\cdots)+(2x7+\cdots)}{3x30} + \frac{(4x40+\cdots)+(2x7+\cdots)+(2x7+\cdots)}{3x30}$$

$$= 9.31 + 45.51$$

$$= 54.82$$

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Description of calculation of paper-based signing-in time:

$\forall date\ stands\ for\ all\ examinations\ date$

$\sum_{t_i}^{t_f}(occurrence\ .\ time_t)\ stands\ for\ summation\ of\ the\ product\ of\ occurence\ and\ time\ from\ time\ t_i\ to\ time_f\ seconds$

$N_{days}\ stands\ for\ number\ of\ examinations\ days\ (date)$

$N_{students}\ stands\ for\ number\ of\ examinations\ days\ (date)$

B: Payment Verification

The paper-based attendance system uses Student identity cards and examination cards given to students who completed the required university fees. The examination card is valid if stamped and contains the correct student's information. Four test cases were used for payment verification: valid examination cards, unstamped examination cards, information mismatch & unstamped examination cards, and no examination cards. In addition, students without examination cards were given tips to persuade the invigilators using excuses like lost cards. Table 5 displays the results of the test cases.

Table 5: Incomplete payment verification baseline

Day	Test Case	# Students	Accepted	Rejected
1	Valid examination card	40	40	0
	Unstamped examination card	20	1	19
	Mismatched & unstamped examination card	20	0	20
	No examination card	7	0	7
2	Valid examination card	30	30	0
	Unstamped examination card	15	0	15
	Mismatched & unstamped examination card	15	0	15
	No examination card	7	1	6
3	Valid examination card	40	40	0
	Unstamped examination card	15	3	12
	Mismatched & unstamped examination card	15	1	14
	No examination card	10	2	8
Total		**234**	**124 (8)**	**110**

From Table 5, a total of 8 students sneaked into examinations venues without meeting the university payment requirements. However, 110 student's attempts for all examinations in the first three days were rejected from the examinations venues for not meeting university payment requirements. Therefore, the paper-based attendance system is 93.22% effective in the verification of incomplete payments.

C: Coursework Verification Baseline

The paper-based attendance system is ineffective in identifying and preventing students with incomplete coursework from taking scheduled university examinations. An attempt might be made to print courses with incomplete coursework (if any) for each student on the examination card, but this would increase the complexity and time for ID checks. Thus, the paper-based attendance system has little chance (0%) of deterring students from taking part in university examinations, even though the results compilation system will not compute their scores.

D: Examination Venue Verification

In practice, the crowded classes are split into several examination venues. Consequently, the challenge of ensuring the even distribution of students to the examination venues arises. Controlling examination venue allocations is impractical because it is time-consuming and may cause unnecessary tensions between invigilators and students. Since

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it is impractical to control examination venues using a paper-based attendance system for crowded classes, the baseline was established on practicability rather than possibility.

5.2 QR code and Fingerprint Attendance System

The general results from the QR code and fingerprint attendance prototype are summarized in Table 6. Furthermore, Table 7 provide detailed results of students' rejection from taking part in university examination.

Table 6: Summary of results from analyzed data collected

Day	ATT	IPM	ICW	ABS	IRR	Total
1	54	20	13	3	0	90
2	34	15	18	1	0	68
3	53	15	12	1	1	82
4	31	11	14	0	0	56
5	54	18	16	1	1	90
6	30	11	18	1	0	60
7	51	20	23	1	1	96
8	9	3	2	0	0	14
Total	316	113	116	8	3	556

Table 7: Rejections Summary

Date	Reasons										Total
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
01	19	2		15	22	8		2	8	76	152
02	7	2		19	15	1			3	63	110
03	8	7		12	16	7			11	50	111
04	21			14	13	3			4	45	100
05	36	6		24	19	10			12	80	187
06	16	4		18	11	11			7	49	116
07	13			24	25	4			9	65	140
08				2	3					5	10
				(116)	(113)						
Total	120	21	0	128	124	44	0	2	54	433	

A: Time Utilization

The developed prototype recorded the time of every student for IN and OUT sessions. The maximum time spent by a student for IN and OUT sessions are 17 and 18 seconds respectively. Table 8 displays the computed results of the time difference between the two consecutive students.

Table 8: Minimum, maximum and average time for entrance and exit sessions

Day	Time	In session			Out session		
		Min(ss)	Max(ss)	Avg(ss)	Min(ss)	Max(ss)	Avg(ss)
01	Morning	09	17	13	13	18	16
	Afternoon	12	17	14	14	18	16
02	Morning	10	16	13	12	18	14
	Afternoon	09	15	12	12	15	14
03	Morning	09	15	11	12	18	14
	Afternoon	08	15	12	07	17	13
04	Morning	09	16	13	11	17	14
	Afternoon	11	15	12	11	14	12
05	Morning	08	17	12	10	17	13
	Afternoon	11	16	13	10	18	14

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06	Morning	10	16	13	10	17	13
	Afternoon	09	16	12	10	16	13
07	Morning	12	17	14	09	17	12
	Afternoon	10	16	12	07	16	13
08	Morning	10	16	13	11	15	13

B: Payment Verification

The QR code and fingerprint attendance prototype rejected all (100%) students set with incomplete payment status from taking part in the examination in all of their attempts. One hundred twenty- four (124) attempts were rejected as "Signing in with incomplete semester payments". However, eleven (11) attempts were denied, such that students attempted to register for an examination more than once. Thus, there were one hundred thirteen (113) total unique rejections from taking part in the examination because of incomplete payment.

C: Coursework Verification

The QR code and fingerprint attendance prototype rejected all (100%) students set with incomplete payment status from taking part in the examination in all of their attempts. One hundred twenty- eight (128) attempts were rejected as "Signing in with incomplete recorded coursework" (repetition inclusive). However, there were one hundred thirteen (116) total unique rejections from taking part in the examination because of incomplete coursework.

D: Examination Venue Verification

From Table 7, the prototype identified 120 (repetition inclusive) students trying to enter the wrong examination venues. In practice, if there is no mechanism for ensuring even distribution of students to examination venues, great disturbance will arise, especially when examination venues are not closely located.

5.3 Responses from Invigilators

A total of twenty (20) invigilators experimented with the prototype; eighteen (18) of them experimented with the prototype more than four times, while the remaining two (2) experimented with the prototype four (4) times. The invigilators rated the performance of QR code and fingerprint attendance system on a scale of 1 to 5, with 1 indicating "strongly disagree", 2 indicating "disagree", 3 indicating "neutral", 4 indicating "agree", and 5 indicating "strongly agree". The summary of results from the invigilators is tabulated in Table 9.

Table 9: Invigilators' response on QR code and fingerprint attendance system

Parameters	**# Invigilators**				
	1	**2**	**3**	**4**	**5**
Easier to record examinations attendance	0	0	0	2	18
Faster, steadier and highly productive	0	0	0	1	19
Effective in organizing and managing attendance records	0	0	0	7	13
Easy and efficient way of tracking students' absences	0	0	0	5	15
Reduces the chances of losing attendance records	0	0	1	2	17
Improves invigilation and overall examination quality	0	0	0	1	19
Stops students with incomplete payments	0	0	0	4	16
Stops students with incomplete coursework	0	0	0	4	16

6 DISCUSSION

6.1 Management and Effective Utilization of Time

The effectiveness of the QR code and fingerprint attendance prototype in managing signing-in time at the worst possibility (using the maximum attendance signing time) is three (3) times faster than the paper-based attendance system. However, on average, the effectiveness of the prototype increases to four (4) times more quickly than paper-based. The fair device-to-student ratio is one device per

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100 students, which means that 100 students will spend at most 28 minutes and 20 seconds in the worst-case scenario. Similarly, 100 students will use a maximum of 30 minutes signing out of the examination venues in the worst-case scenario.

6.2 Management and Verification of Payments

Most universities put in their regulations and by-laws that completion of fees and related payments is the requisite for students to sit for university examinations, so accuracy and instant verification of payments are essential. Moreover, most universities use examination cards for authentication and verification of payments. Examination cards are less effective since students may lose or forget them, resulting in their denial in examination venues. Similarly, students without an examination card could sit for an examination just by declaring they have lost their cards. The developed prototype succeeded in identifying and denying all (100%) students having incomplete payments from entering the examination venues. Thus, the prototype is effective in payment verification compared to the paper-based attendance system, which has a 93.22% chance of identifying and denying students with incomplete payments. Therefore, it implies that the prototype will reduce the number of students sneaking into examinations to zero.

6.3 Management and Verification of Coursework

Completing coursework provides eligibility for students to sit for university examinations in most universities. The QR code and fingerprint attendance prototype identified and denied all students with incomplete coursework from entering the examination venues. Therefore, the prototype resolved challenges associated with the paper-based attendance system's inability to identify and deny students with incomplete coursework immediately.

6.4 Management and Verification of Examinations Venues

The proportional ratio of examination venue capacity to the number of students is one of the quality assurance factors. Usually, crowded classes are split into small groups and allocated to different examination venues. However, the ratio of venue capacity to the number of students may not be achieved if there is no practical mechanism for monitoring and controlling student allocation to the examination venues. The paper-based attendance system is unsuitable for handling students' distribution to examination venues because it is time-consuming and may result in tensions between students and invigilators. The fingerprint and QR code attendance prototype is more efficient than the paper-based attendance system because students will only be registered in venues designated for them in a particular examination.

6.5 Other Benefits of QR and Fingerprint Attendance System

First, Cost reduction. The use of QR code and fingerprint attendance system for university examinations will eliminate the need for examination cards. Furthermore, the attendance system will eradicate printing costs and honoraria payments for preparing and issuing examination cards. Therefore, cost reduction in a long-term run.

Second, Easiness of invigilation. The QR code and fingerprint attendance system eliminates the need for passing attendance sheets during examinations. Furthermore, invigilators will bear no responsibility for ensuring students register their attendance only once and write their correct particulars since the QR code and fingerprint attendance system will handle these requirements. Third, Management of Cheating and Dishonest in Examinations. The paper-based is not free from impersonation, especially during special and supplementary examinations. Impersonation is a severe threat since unqualified students may graduate with higher scores, hence poor productivity, or even causing danger and death at their workplaces. The QR code and fingerprint attendance system provide no room for impersonation because only qualified students sit for examinations, and the examination marks templates will result from their biometric attendance record.

Fourth, Management of Absence and Absconding Cases. Being absent in a university examination without permission or valid reasons forms an examination irregularity. Unlike the paper-based attendance system, the QR code and fingerprint attendance system offers an instant and accurate list of absent students during examinations.

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7 RECOMMENDATIONS FOR FUTURE WORK

i. Stopping marking favoritism and corruption. A unique QR code printed on each examination answer booklet may act as the only student identifier, requiring students not to write their particulars on the booklets. Future studies may develop algorithms requiring lecturers to scan the score and QR code on the examination answer booklets. Furthermore, the algorithms should map the score and its QR code to identify the student and assign the score.

ii. Examination answer booklets auto-sorting. In practice, students of several programmes use the same venue sitting for different courses during university examinations. Future studies may find a mechanism for examination answer booklets auto-sorting during submissions. An intelligent system that sorts and arranges examination booklets by course code will eliminate the problem of booklet misplacement during submissions.

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