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AI Powered Smart Classroom Assistance Using IOT

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Abstract

As part of the process of modernizing student housing to meet the needs of today's students, it is essential to address parental, legal, and ethical issues while also making sure that students are safe. Although efficient and effective access control procedures are crucial, the human monitoring of entry and exit points often results in inefficiencies and unlawful access. In order to ensure the safety of all students at King Abdulaziz University, this article details the planning and execution of a Smart Attendance Management System (SAMS) that uses a fingerprint-based access system. The system registers each student in a biometric database. Automating attendance procedures and ensuring that only authorized persons may access the facility are two of the many benefits of this system. The elimination of conventional paper-based processes, which are sometimes cumbersome and error-prone, is another advantage. In the event of any unforeseen delays, administrators are notified immediately since the technology monitors student mobility in real-time. The technology also notifies students and security staff via SMS of the times of admission and leave, which improves communication and security. In order to strengthen the security of student housing and fix current vulnerabilities, our study will examine access and leave trends.

Keywords—student housing, safety, access control, fingerprint, attendance management system, biometric security, real-time monitoring, entry and exit patterns, King Abdulaziz University

INTRODUCTION

The intellectual and psychological growth of university students is greatly affected by student housing. Academic achievement and safety are both improved by well-managed dorms, but retention and performance are adversely impacted by subpar amenities [1, 2]. Student attention and pleasure are further diminished by inadequate security [3], [4]. Conventional methods of managing dorms rely on labor-intensive and prone to human error [5, 6]. Manual attendance is laborious and not always precise [7], [8], and key card methods are often circumvented [9], [10]. Biometric systems and the Internet of Things (IoT) are examples of technological advancements that provide better solutions, increasing security and automating processes [11]-[14]. The Internet of Things allows for the real-time monitoring of students' whereabouts [17]-[20], while biometric technologies, such as fingerprint and face recognition, provide trustworthy identification verification [15], [16]. An automated attendance management system is urgently needed at King Abdulaziz University (KAU) because of the increasing number of students and the necessity to address safety issues. This research presents a Smart Attendance Management System (SAMS) that automates attendance tracking and offers real-time monitoring in dorms by using fingerprint-based access management. Both students and security staff will get text message notifications when it is time to enter and exit. The purpose of this research is to examine the planning and execution of a Smart Attendance Management System (SAMS) for the KAU residence halls that makes use of fingerprint-based access control. Secure and effective entrance management is made possible by the proposed system's automated attendance tracking, which involves registering each student in a biometric database. Administrators can quickly respond to any suspicious activity or

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security breaches thanks to real-time monitoring of student movement. Finally, the technology helps with parental, ethical, and legal concerns by facilitating communication between students and security staff about arrival and departure hours via SMS notifications. This research intends to: • Create a reliable biometric attendance management system for KAU dorms. • Find and fix security holes by analyzing entrance and exit patterns. • Strengthen security measures for the benefit of students by implementing more precise access controls and continuous monitoring. Here is how the remainder of this paper is structured: Research on biometric security systems and dorm management systems is reviewed in Section II. In Section III, the technique of the proposed SAMS is detailed. The findings and discussion of the system's efficacy in improving security and operational efficiency are presented in Section IV. The article is wrapped up and new study options are proposed in Section V. As an example, this template's head margin is proportionally larger than the norm. Along with other measurements, this one is purposeful and based on requirements.

BACKGROUND AND RELATED WORK

Home safety for students is of the utmost importance. Poor safety measures distract students, according to Sadique and Alam [3], who advocated for RFID-based student authentication as a solution. With biometric security, access control is made much better. To make dorms more accessible and secure, Ejaz et al. [7] used facial recognition entry systems. In order to automate attendance and increase security, Fernandez [9] built a dorm management information system that includes SMS notifications and biometric security via fingerprint scanners. Biometric identity, barcodes, and QR codes were some of the innovations in automated attendance that Yelve [20] looked into. A safe approach for automatically tracking student attendance in class was introduced by Goud et al. [21]. It makes use of facial recognition technology. Automated attendance and alerts were developed by Rahim et al. [22] to improve monitoring of absence using email and text message reminders. Using fingerprint sensors, Shoewu et al. [23] created SAMSYS, an attendance management system applicable to all grade levels. Embedded systems, QR codes, RFID/NFC, and facial recognition were among the automatic attendance technologies studied by Jahangir et al. [24].

METHODOLOGY

A multi-stage approach to accomplishing research goals, this study employs the Business Process Management (BPM) lifecycle methodology. Using Bizagi-created Business Process Model and Notation (BPMN) diagrams, this section demonstrates the enhanced SAMS's process discovery, analysis, and re-design. First, we have process discovery. An accurate description of the event sequence is the goal of process discovery, which entails developing a process model. One way to visualise a process is via a process model. There are many other ways to draw, however we used BPMN with Bizagi. Figure 1 depicts the entrance processes for KAU student housing under the As-Is model. First, students need to visit the admission office to get an entry ticket, which they may then use with their ID card. Students need to fill out their personal information (name, ID number, building, apartment, room, date, time, and signature) and present it at the security gate when they obtain the ticket.

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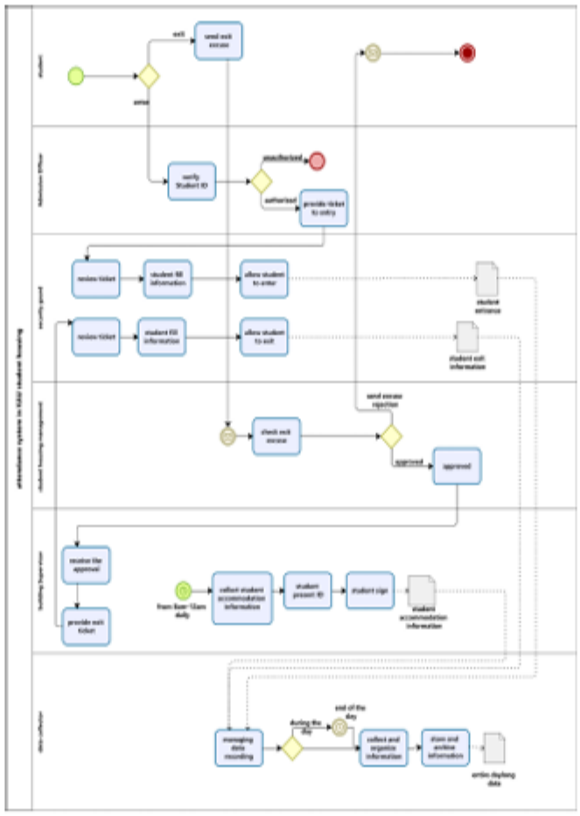

Fig. 1. Student housing entry/exit procedures at KAU.

Students are required by the student housing administration to provide an exit reason in order to complete the leaving processes. If the student's excuse is accepted, it will be delivered to the building supervisor. Otherwise, the student will get a refusal notice. Students must verify their legal justification with the building supervisor in order to finish the leaving procedure. Before departing, they are required to fill out an exit ticket with their personal information (name, ID number, building, apartment, room, date, time, and signature). This ticket must be shown to the security officer when they check out. In addition, each student must log in every day to verify their overnight lodging. Every day, between the hours of 8 AM and 12 PM, this signature is required. Analysis of Processes (B) Three Key Business Indicators (KBIs) will be tracked to assess the efficacy of these procedures: Student happiness Score with Attendance Process—a measure of student happiness in the event that the new system (To-Be) is implemented—took into account the following metrics: total expenses, total time for every task, and operational efficiency of the attendance process. Integrating quantitative and qualitative methodologies, the study used process analysis that was based on Key Business Indicators (KBIs) for assessment. The quantitative techniques and methodologies will be detailed in the parts that follow, after which the qualitative methods will be described. 1) Examining Data Analytically: a) Cause-and-effect Analysis: The fishbone diagram is a useful analytical tool for determining the origins of a problem by tracing its chain of probable causes. Figure 2 shows a fishbone diagram that identifies six factors that contribute to the manual attendance system's underlying issue.

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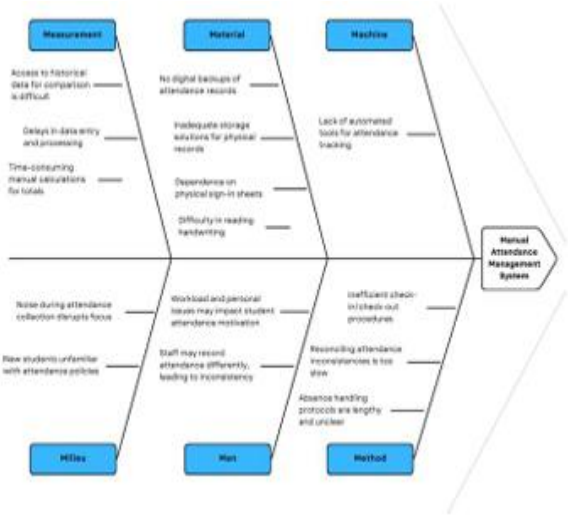

Fig. 2. Cause-effect analysis for KAU (As-Is model).

The graph showing survey findings uses a Pareto chart to show how often people answered five important questions about the existing manual system. The questions were asked on a 5-point scale. As shown in Figure 3, this chart makes it simple to see the frequency of answers visually.

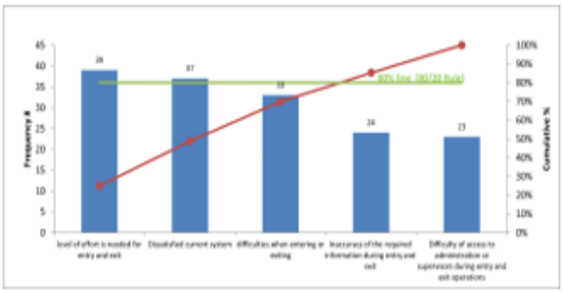

Fig. 3. Pareto Chart of Student Housing Survey with Cumulative line and 80% cut off.

contrasting the many problems. One of the key business indicators (KBIs) we concentrate on is student satisfaction levels, and this visualization helps highlight areas that require improvement. The majority of students make a concerted attempt to access and depart their student accommodation, as seen in Table I.

TABLE I RESULT OF PARETO CHART CUMULATIVE AND CUMULATIVE TOTAL

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Causes	#	Cum. Total	Cum.	80/20 rule
Level of effort needed for entry and exit	39	39	25%	80%
Dissatisfaction with the current system	37	76	49%	80%
Difficulties when entering or exiting	33	109	70%	80%
Inaccuracy of the required information during entry and exit	24	133	85%	80%
Difficulty of access to administration or supervisors during entry and exit operations	23	156	100%	80%
Total	**156**	–	–	–

Analyzing Data Quantitatively a) As-Is Model Simulation: By simulating one thousand check-in and exit requests from student housing, important improvement opportunities are identified. Table II shows that the most time-consuming activities are data storage and collection related to housing, both of which emphasize the need of effective data management due to the difficulty of dealing with paper-based records. It takes a lot of time to evaluate departure justifications, which shows that compliance is a problem. Studying Data Quantitatively: a) Running the As-Is model simulation uncovers critical improvement opportunities by simulating 1,000 student housing check-in and exit requests. Table II shows that the most time-consuming activities are data storage and collection related to housing, both of which emphasize the need of effective data management due to the difficulty of dealing with paper-based records. It takes a lot of time to evaluate departure justifications, which shows that compliance is a problem. A substantial financial burden is shown by Table III, which summarizes the resource costs associated with different roles in the entry/exit process. those requiring data collection cost SAR 36,000 per hour, whereas those requiring administration of student housing cost SAR

TABLE II PROCESS TIME ANALYSIS OF AS-IS MODEL

Process	Average time	Total time
Collect student accommodation data	20410	4877990
Store and archive information	5730	5729670
Check exit excuse	5094	2577370
Collect and organize information	5042	5041580
Manage data recording	3089	3088530
Fill information	5	2335
Send exit excuse	5	2530
Verify Student ID	3	1482
Student sign	1	239
Review ticket	1	234

8.433.33 SAR for 2 security guards, 240.50 SAR for 1 admissions officer, 41,782.96, and 86,694.98 SAR for 4 building supervisors. Effective management requires a large investment, as this highlights.

TABLE III RESOURCE COSTS OF AS-IS MODEL

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Resource	Cost per hour	Total cost
Admission officer	SAR 25.00	SAR 238.19
Security guard	SAR 20.00	SAR 240.50
Building supervisor	SAR 20.00	SAR 41,782.96
Data collector	SAR 20.00	SAR 36,000.00
Student housing management officer	SAR 25.00	SAR 8,433.33
Total costs	SAR 110.00	SAR 86,694.98

Redesigning the Process Following the process discovery section's description of the prior process, the new BPMN model (To-Be model) presents the solution that has been suggested. The procedure starts when a student checks in, as seen in Figure 4. To authenticate the student's identity, the system first scans their fingerprint. The system obtains the student's details and sends it to the security guard if approved. This updates the student's information and grants them access to enter. The student notifies housing administration of their intention to leave by submitting a departure excuse via the system. Upper management decides whether to accept or reject the justification after reviewing it. The student will be notified of their rejection via email. The student is contacted and the information are provided to the security guard if they are accepted. When the student is ready to leave, they scan their fingerprint at the gate, which updates their record. The student is required to scan their fingerprint between 8 AM and 12 PM at the office of the building supervisor in order to get accommodation. The information about the lodgings is thereafter entered into the system database.

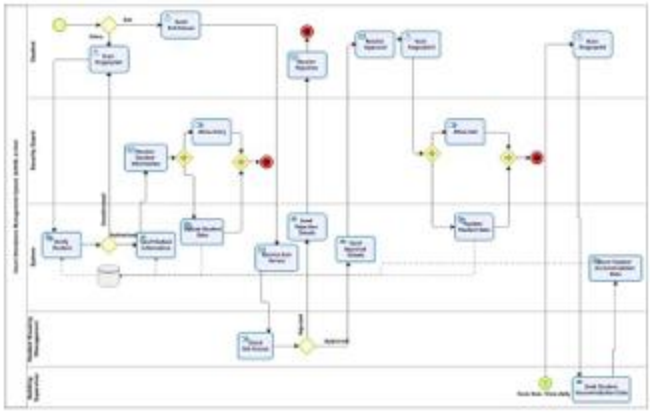

Fig. 4. Student Housing Entry/Exit at KAU (To-Be model).

RESULTS AND DISCUSSION

This section compares and contrasts the As-Is and To-Be models and examines the To-Be model's simulation. Section A - Findings 1) Modeling the Future State: The suggested solution's simulation (To-Be model) examined one thousand entry and exit procedures. One of our key business indicators (KBIs) is confirmed by the large discrepancy between the average processing times of the As-Is and To-Be models, as shown in Table IV. The "Check Exit Excuse" and "Send Student Accommodation Data" procedures take the longest average times, respectively, because of the student housing management officer's workload and the duty of building supervisors. All other steps take less than a minute to complete, therefore it stands to reason that a fingerprint-based attendance system may greatly shorten the time it takes to check-in and depart.

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TABLE IV TOTAL TIME FOR THE TO-BE MODEL

Process	Average time	Total time
Check Exit Excuse	30.00	13980.00
Send Student Accommodation Data	10.00	5000.00
Store Student Accommodation Data	0.17	83.33
Send Approval Details	0.17	60.83
Send Rejection Details	0.08	8.42
Update Student Data	0.08	44.50

Compared to the prior approach, the implementation of a fingerprint-based attendance system reveals a significant decrease in resource expenditures. Important functions now cost less in the revised framework: Student Housing Management Officer: 6,017.29 SAR, Security Guard: 207.86 SAR, and Building Supervisor: 3,361.11 SAR. From SAR 86,694.98, the overall expenditures have decreased to SAR 49,586.26. Although the biometric system does away with data collectors and the admissions officer, it does come with a fixed cost of SAR 40,000.00 and needs minimum maintenance. By simplifying the entrance and departure procedures, this modification improves operational efficiency while decreasing human expenses. The comparison shows how student housing operations may save money and make better use of resources by incorporating technology into attendance monitoring.

TABLE V RESOURCE COSTS OF THE TO-BE MODEL

Resource	Cost per hour	Total cost
Building Supervisor	SAR 20.00	SAR 3,361.11
Security Guard	SAR 20.00	SAR 207.86
Student Housing Management Officer	SAR 25.00	SAR 6,017.29
System	SAR 00.00	SAR 40,000.00
Total costs	–	SAR 49,586.26

An evaluation of the suggested SAMS rollout was carried out using the Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) approach. According to the results, the manual system had a Sigma level of 2.3 and about 308,538 DPMO, mostly as a result of data input mistakes, delays, and illegal access attempts. Processing speed, data accuracy, and security compliance were key Critical to Quality (CTQ) indicators. Over the course of three months, SPC charts were created to reveal that the manual system often went over the Upper Control Limit (UCL) for processing times. On average, it took 25 minutes each transaction, although the goal time was 5 minutes. System adaption and user training were the primary factors in reducing DPMO to 5,600 and improving the sigma level to 4.1 after the SAMS pilot program. The upgraded system consistently performed within control limits, completing transactions in an average of 2 minutes. Among the most important enhancements found by Six Sigma study are: • A variability in processing time that is 92% less • A reduction in data entry mistakes of 98.2% Unauthorized access protection has improved by 99.7 percent. These indicators demonstrate that the system can consistently achieve the quality criteria while keeping the process stable and predictable. The distribution histograms displayed in Figure 5 demonstrate that the processing times for the manual system are distributed over a large range of 15–35 minutes, with a bell-shaped curve leaning towards longer times. In contrast, the automated system displays a significantly more compact and normal distribution, with a concentration between 1.5–2.5 minutes. This visually confirms the reduction of 92% in process variation. The following data provide a quantitative view of this improvement, demonstrating a drop in standard deviation and an average processing time reduction from 25 minutes to 2 minutes, both of which point to a more stable and predictable process. Thirdly, a SWOT analysis of SAMS shows that the system offers a technical solution that has great operational potential.

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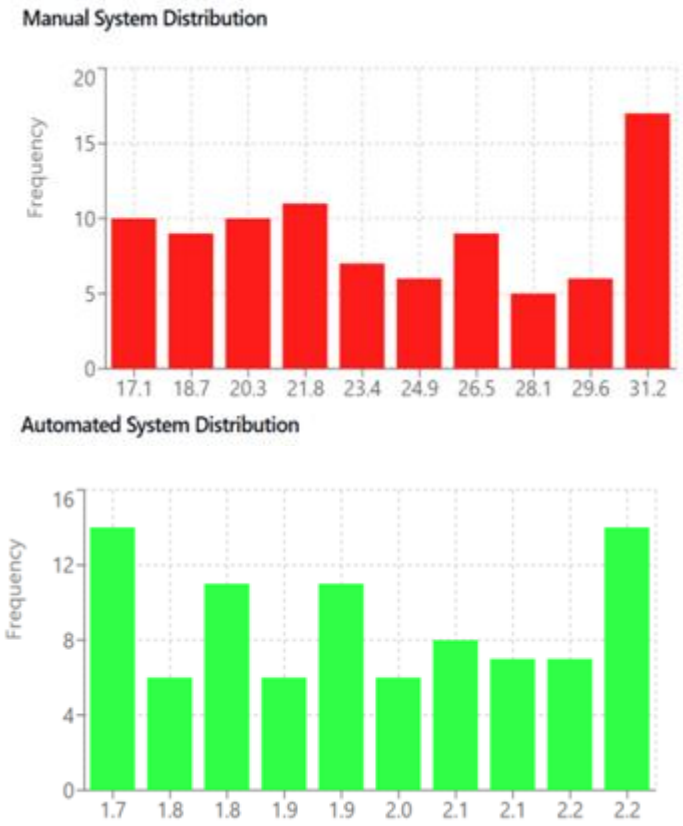

Fig. 5. Distribution histograms of the manual (top) and automated (bottom) processesing times.

Advantages, even with a few problems with execution. A 42.8% drop in operating expenses, processing times down to less than 1 minute, and improved security measures with a 99.7 percent increase in preventing unauthorized access are the main quantitative improvements that show the system's capabilities. The system's potential for technical progress and scalability across campus buildings more than makes up for its shortcomings, such as the hefty starting fixed cost of SAR 40,000 and privacy concerns with biometric data storage. According to the results, paying close attention to the known risks is essential for the success in the long run, especially when it comes to user adoption and system stability. Table VI provides a concise summary of the various SWOT analyses and their associated parts.

TABLE VI SWOT ANALYSIS OF TO-BE MODEL

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Category	Elements
Strengths	• 42.8% operational cost reduction • Enhanced security and data accuracy • High user satisfaction (90%) • Real-time processing
Weaknesses	• High initial cost (SAR 40,000) • Training requirements • Technical infrastructure needs
Opportunities	• Technology integration potential • Campus-wide expansion • Analytics capabilities
Threats	• System reliability concerns • Data security risks • User adoption challenges

TABLE VII KPI ACHIEVEMENT LEVELS FOR VARIOUS METRICS

Metric	As-Is Model	To-Be Model	Improve-ment
Total resource costs	SAR 86,694.98	SAR 49,586.26	42.8%
Process Sigma level	2.3	4.1	78.3%
Data entry errors	Baseline	98.2% reduction	98.2%
Unauthorized access prevention	Baseline	99.7% improv.	99.7%
Average processing time	25 minutes	2 minutes	92.0%
Process variation	High variation	92% reduction	92.0%
Student satisfaction	Baseline	90% positive	90.0%

Evaluation in Comparison There are noticeable enhancements to the fingerprint-based attendance system when comparing the As-Is and To-Be models. Due to many staffing positions, the As-Is model, which is based on paper, incurred significant expenses of SAR 86,694.98. Because positions such as Data Collector and Admissions Officer are eliminated in the suggested model, expenditures are reduced to SAR 49,586.26. Also, processing times have dropped significantly; the To-Be model can do most activities in under a minute, whereas the As Is model takes much longer, particularly for complicated jobs like "Check Exit Excuse." Students are more satisfied and operating expenses are lowered as a result of this efficiency. Ninety percent of the fifty KAU students surveyed agreed that the suggested approach would improve efficiency, speed, and security. According to student reviews, the fingerprint system has a lot of potential to enhance students' lives and the way they go about their everyday tasks. Comparing Models and Conducting Cost-Benefit Analysis 1) A Deep Dive into Model Comparisons: Across a number of operational aspects, Table VIII compares the As-Is and To-Be models in great detail: 2) Cost-Benefit Analysis: Although there is an upfront cost to implementing SAMS, the payoff is enormous in the long run.

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Fig. 6. A sample question of the student satisfaction survey.

TABLE VIII COMPREHENSIVE COMPARISON OF AS-IS AND TO-BE MODELS

Parameter	As-Is Model	To-Be Model	Impact
Staff requirements	15 personnel	7 personnel	53% reduction in staffing
Daily processing capacity	150 transactions	450 transactions	200% increase in capacity
Error rate	5.2%	0.09%	98.2% reduction
Average wait time	25 minutes	2 minutes	92% reduction
Data storage	Physical storage	Digital database	Improved acces-sibility
Real-time monitoring	No	Yes	Enhanced secu-rity
Emergency response time	30+ minutes	< 5 minutes	83% improvement
Annual maintenance cost	SAR 25,000	SAR 8,000	68% reduction

Initial investment, yearly benefits, and return on investment (ROI) are broken down as follows: Upfront Expenses: • Computer hardware (servers, fingerprint scanners): 25,000 SAR • SAR 10,000 for software development and licencing • SAR 5,000 for setup and infrastructure • SAR 3,000 for employee education An initial investment of 4,300 Saudi Riyals Benefits Given Yearly: • SAR 37,108.72 in savings from staff • Saved 12,000 Saudi Riyals on paperwork and materials • SAR 17,000 in maintenance savings SAR 15,000 for enhanced efficiency Total Benefits Over a Year: SAR 81,108.72 Financial Return (ROI) Analysis: • Net benefit for the first year: SAR 38,108.72 SAR 200,326.16 is the estimated net benefit after three years. 6.4 months is the break-even threshold. After one year, the return on investment is 88.6 percent. A careful examination of the system's costs and benefits reveals that, despite a hefty upfront payment, it more than covers its expenses in the first year of use. Substantial value is delivered to the institution as a result of decreased operating expenses, increased efficiency, and greater security capabilities. There will be ongoing returns beyond the three-year benefit, demonstrating the long-term financial value of adopting SAMS. 3) In addition to measurable benefits, the method also provides a number of qualitative advantages: • A more favorable image for the organization Students and parents are more satisfied as a result. • Increased adherence to safety standards Lower potential for legal action • Making better decisions with more accurate data Less paper use has positive effects on the environment Reduced manual chores led to an increase in staff work

satisfaction. This thorough study backs the introduction of SAMS, a wise investment that will benefit the institution, its employees, and its students in the short and long term.

CONCLUSION AND FUTURE WORK

In summary Student housing at King Abdulaziz University was much improved in terms of efficiency, security, and user happiness after implementing the Smart Attendance Management System (SAMS), which is detailed in this paper. There have been huge gains since switching to an automated biometric system from a paper-based, manual method. Thanks to simplified procedures and the elimination of redundancies, operating expenses for 1,000 entry/exit requests dropped from SAR 86,694.98 to SAR 49,586.26, a 42.8% decrease, according to quantitative analysis. Most transactions now take less than a minute, down from nearly twenty minutes before, all thanks to fingerprint authentication. The process sigma level increased from 2.3 to 4.1, suggesting improved quality and consistency, as proven by Six Sigma analysis. The success of the system was shown by a 98.2% decrease in data input mistakes and a 99.7 percent improvement in illegal access prevention. Ninety percent of students who took part in the poll were very satisfied, with many complimenting the increased efficiency and security. In addition to resolving previous concerns about transparency, the automatic notification system has improved communication among students, security staff, and housing officials.

Future Work

Despite the initial success of SAMS, there are still many unanswered questions and opportunities for improvement. To improve the system's capabilities, technical upgrades might include adding face recognition technology, creating mobile apps, and using cloud-based data analytics. Possible areas for process improvement include pattern identification using machine learning algorithms, optimization of resources using predictive analytics, and integration with current campus systems. Longitudinal effect studies to measure student happiness, comprehensive cost-benefit evaluations in different academic contexts, and cross-cultural factors for international rollout should all be the subject of future research. All things considered, biometric attendance systems greatly improve the administration of student housing, leading to greater safety, efficiency, and happiness for everyone involved.

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