ORIGINAL ARTICLE

SmartTasjeel: A GPS-Based Automated Attendance Tracking System for Medical Education Built on Microsoft PowerApps

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ABSTRACT

Background: Attendance in medical undergraduate programmes is consistently associated with academic performance, which makes accurate per-session tracking essential for early identification of at-risk students. At the Department of Basic Medical Sciences, Kulliyyah of Medicine, International Islamic University Malaysia, the previous biometric thumbprint system captured only twice-daily entries and excluded students with dermatological conditions affecting fingerprint recognition. This made per-session attendance percentage calculations impossible to automate. **Methods:** We report a descriptive operational deployment and systems evaluation of SmartTasjeel, a GPS-based attendance system built entirely on free Microsoft 365 Education licences using PowerApps, SharePoint Online, and Excel with Power Query. The system uses geofencing validation with a 0.001-degree tolerance (approximately 110 metres at the campus latitude) and matches each time-in to a session pulled from track-specific timetables. It was deployed for 285 students across three curriculum tracks. **Results:** Per-session attendance processing dropped from 30 minutes (paper) or 10 minutes (biometric queues) to under 15 seconds which a reduction of approximately 99.2% versus the paper-based baseline and 97.5% versus the biometric-queue baseline. Weekly percentage calculations dropped from around 2 hours of manual computation to under 30 minutes of automated dashboard review. Data granularity increased from a maximum of 10 weekly capture points (biometric) to 20–25 per student (per-session). No attendance calculation errors were identified during routine coordinator review across two academic semesters. Hardware cost dropped from RM3,500–7,000 (biometric machines) to zero. Students previously excluded by fingerprint recognition issues were able to participate. **Conclusion:** SmartTasjeel demonstrates that GPS-based automated attendance tracking can be implemented using only free Microsoft 365 Education licences, with no premium connectors, no custom code, and no additional hardware purchase, making it especially relevant for resource-constrained medical and health education institutions. The architecture is transferable to other institutions and the per-session data structure supports policy enforcement, warning-letter workflows, and student self-monitoring. Future work should formally evaluate whether real-time attendance feedback influences student attendance behaviour and academic performance.

INTRODUCTION

Attendance among medical undergraduates is one of the more consistent predictors of academic success in the literature. A systematic review by Doggrell (2020) covering 32 courses in the human biosciences found a positive association between lecture attendance and academic outcomes in 75% of courses overall, rising to 82% among courses for dental and medical students. Meanwhile, Al Shenawi et al. (2021) reported a positive correlation between attendance and performance in undergraduate surgical clerkship ($r = 0.360$, $p < 0.01$), with excellent performers maintaining a mean attendance rate of 83.16% compared with 47.95% among weak performers. These findings make accurate attendance tracking a meaningful operational concern in medical education, not just an administrative formality.

At the Department of Basic Medical Sciences, Kulliyyah of Medicine, International Islamic University Malaysia (IIUM), attendance for 285 students across three curriculum tracks initially relied on paper signatures. The risk of signature forgery prompted the transition to biometric thumbprint systems. However, biometric tracking introduced its own set of problems such as long queues formed at peak times. Additionally, students with dermatological conditions affecting fingerprint recognition were also excluded. Data transfer from biometric device also required manual transfer using thumb drives, which were unreliable. Most critically, the biometric system captured only twice-daily time-ins rather than per-session entries. This made it impossible to calculate accurate per-

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session attendance percentages, which is very important to the department because the need to issue warning letters at specific thresholds and for barring students who fall below minimum attendance requirements.

Several GPS-based and geofencing attendance systems have been described in higher education contexts, including dedicated Android applications (Babatunde et al., 2022) and Microsoft PowerApps-based platforms for medical education (Rajaram et al., 2022), and purpose-built GPS-based attendance tracking systems in engineering education contexts (Ravikumar et al., 2026). What is less well documented is whether a complete attendance ecosystem consisting of an interface, geofencing logic, relational database, per-session matching, and analytics dashboard that can be built end-to-end using only free Microsoft 365 Education licences, with no premium connectors and no custom programming. Analytics dashboards integrated into such systems have been shown to increase student engagement and support self-directed attendance monitoring in higher education (Ramaswami et al., 2023). This is very important as digital transformation in tertiary education has been described as a means to replace traditional administrative methods with cost-effective technological solutions in resource-constraint institutions (Althubaiti et al., 2022; Anisimova et al., 2024; Truong & Diep, 2023). Hence, the gap between this general framing and a working, replicable institutional deployment is rarely closed in published reports.

Babatunde et al. (2022) describe a dedicated Android application requiring device installation and custom programming, and Rajaram et al. (2022) implement a Microsoft PowerApps-based platform in medical education. Both studies do not report a zero-cost, fully integrated ecosystem that eliminates manual attendance processing, which is from student check-in to coordinator dashboard in a single, automated workflow. SmartTasjeel addresses this gap by combining GPS-based geofencing, automated per-session matching, and real-time analytics within a free Microsoft 365 Education licence, deployed in a resource-constrained Malaysian medical institution without custom programming or premium connectors.

In this paper, we describe SmartTasjeel ("Smart Registration" in Arabic), a GPS-based attendance system built on free Microsoft 365 Education licences. The system uses geofencing validation, captures per-session attendance with automatic curriculum detection, and provides students with real-time self-monitoring of their attendance percentages. This paper is presented as a descriptive operational deployment evaluation, drawing on deployment data rather than experimental or behavioural testing; formal user-experience evaluation is identified as a direction for future work.

MATERIALS AND METHODS

System Architecture

SmartTasjeel uses a four-layer cloud-based architecture: a PowerApps mobile application as the user interface, GPS geofencing with automatic curriculum detection as the application logic layer, SharePoint Online with eight relational lists as the data layer, and an Excel dashboard synchronised through Power Query as the analytics layer (Figure 1). The SharePoint database consists of TimeInData (timestamped attendance records), three timetable lists corresponding to the curriculum tracks (Year 1 Semester, Year 1 Block, and Year 2 Block), an Authorised Student List with curriculum assignments, a LocationMasterList containing venue GPS coordinates, and PBL group assignment lists. This structure allows the system to detect each student's curriculum track and match the time-in to the correct session without any manual coordinator intervention.

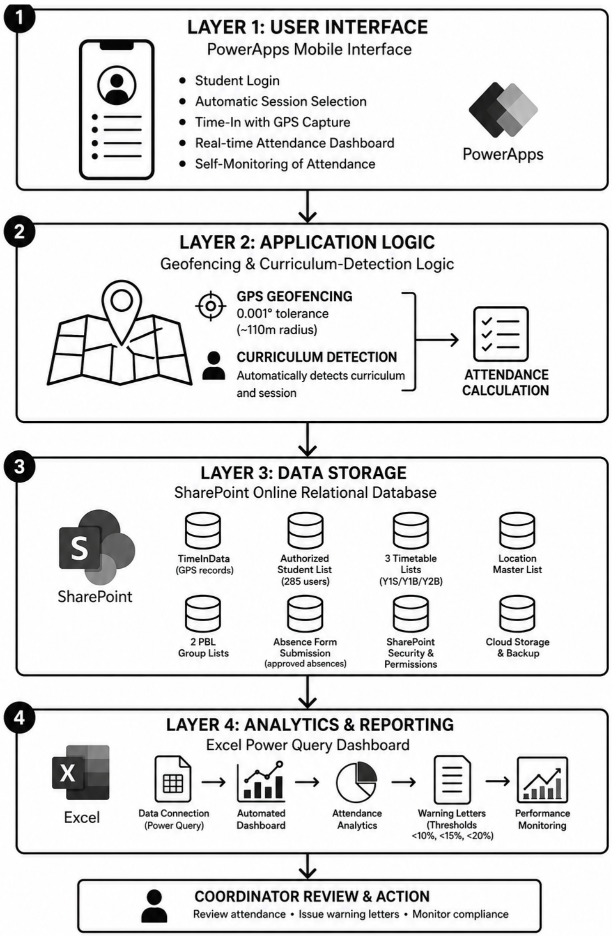


Figure 1: The four-layer cloud-based architecture of SmartTasjeel showing the PowerApps mobile interface, the geofencing and curriculum-detection logic layer, the SharePoint Online relational database, and the Excel/Power Query analytics dashboard.

The whole system was developed using only the components available in free Microsoft 365 Education licences. No premium connectors, no Power Automate workflows, and no third-party purchases were required. Record counts in each SharePoint list stayed below the PowerApps 500-record delegation threshold, so no delegation workarounds were needed. Total development cost was zero.

GPS Geofencing

The verification mechanism compares each student's GPS coordinates against the LocationMasterList using a 0.001-degree tolerance threshold, which corresponds to approximately 110 metres at the latitude of IIUM Kuantan campus. This precision is tight enough to prevent dormitory-based fraudulent time-ins but generous enough to accommodate legitimate venue proximity (for example, students standing just outside a packed lecture hall). For sessions designated as virtual, the system bypasses GPS verification automatically so that remote learning days do not register as false absences. This tolerance value was determined through manual on-site boundary testing, calibrated to approximately cover the full footprint of the Kulliyyah of Medicine building. A wider radius than a single lecture hall was required because sessions are conducted not only in lecture halls but also in dissection halls, laboratories, and seminar rooms distributed across the building. Version 1.0 of SmartTasjeel was deployed and operated for over six months prior to this report with no reported geofencing failures, providing operational validation of the threshold. The system creates no record for an out-of-range time-in attempt and does not log failed attempts by design; only successful time-ins are recorded. There are therefore no false positives by design. The rate of failed time-in attempts cannot be quantified retrospectively; this is identified as a system limitation.

Student Interface

The application has three screens: a login screen, a time-in screen, and an attendance monitoring screen. The login screen automatically displays the student's name and matriculation number based on the university Microsoft 365 credentials account. From the login screen, the student navigates to the time-in screen, which displays a dropdown for the semester or block, a topic selection that auto-populates from the timetable, and real-time GPS location verification. The time-in logic prevents duplicate records for the same session.

Version 2.0 added a self-monitoring feature that shows real-time attendance percentages calculated as (sessions attended ÷ total sessions conducted) × 100. The percentages are presented in three categories: Total Attendance, On-Time Attendance, and Late Attendance. All are colour-coded as Green (≥90%), Orange (≥80%), and Red (<80%) (Figure 2). The intention behind this feature is to shift students from passive end-of-block notification to active self-awareness of their own attendance status in real-time.

Coordinator Workflow

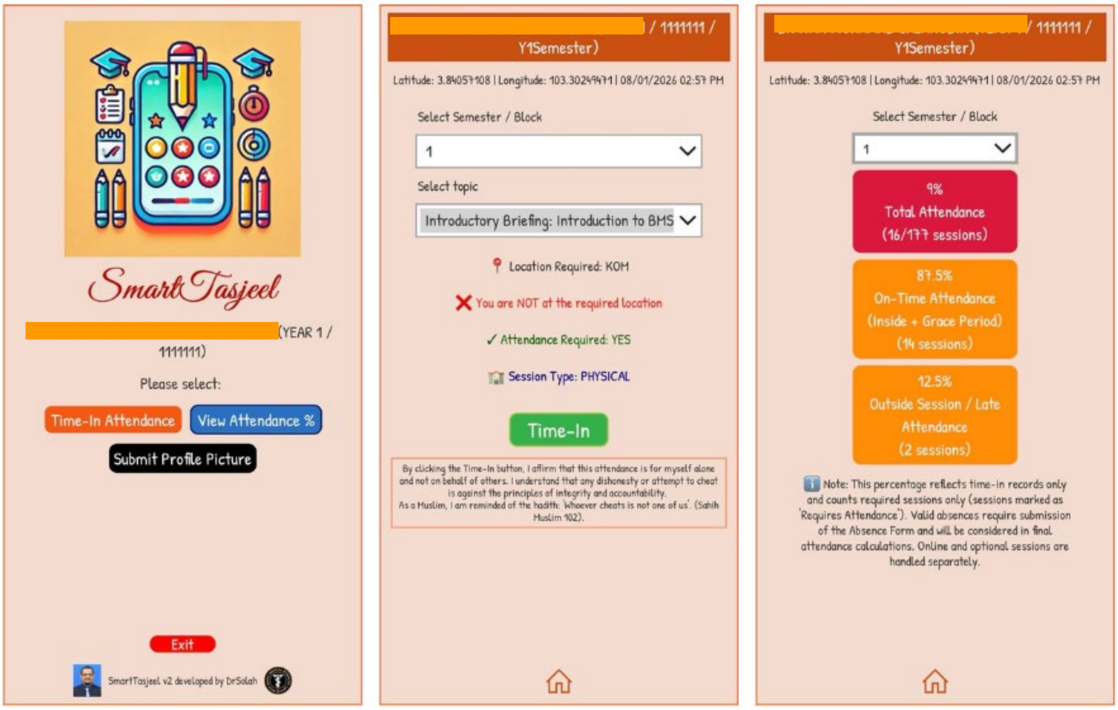
Attendance coordinators can review an Excel dashboard with Power Query. The Excel dashboard automatically refreshes from the SharePoint database. The mid-block review of student attendance percentage takes approximately 30 minutes or less. The coordinators also need to cross-reference the automated percentages with the absence approval database before finalising the net percentage and therefore can issue a warning letter. Student training required only brief demonstrations of the four-step time-in process. Timetable updates are currently performed manually by the system administrator directly within the SharePoint timetable lists. The block or year coordinators must inform the administrator of any session timing or venue changes for manual entry. The interface was designed for rapid use, with an estimated time of under 15 seconds from app launch to confirmed time-in.

Data Security and Privacy

Student authentication is handled through institutional Microsoft 365 single sign-on. Therefore, no separate credentials are created or stored within SmartTasjeel itself. GPS coordinates are captured only at the moment of time-in and are not used for continuous or background location tracking. Access to the SharePoint lists is restricted to attendance coordinators and the system administrator via SharePoint permission groups, and all data transmission occurs over Microsoft's standard encrypted HTTPS connections within the IIUM Microsoft 365 Education tenant. External or third-party accounts are not involved at any point in the data workflow.

Statistical Analysis

As this study reports operational deployment outcomes rather than an experimental comparison, descriptive statistics (totals and percentages) were used to summarise system performance; inferential statistical testing was not undertaken and was not appropriate for the available data. Processing times are practical estimates rather than formal time-motion measurements, as actual time varies with individual device performance and campus WiFi connection speed at each venue. Failed time-in attempts (GPS location outside the authorised geofence, or use of a device without enabled location services) are not separately logged by the current system; only successful time-ins are recorded. Consequently, the rate of failed attempts and GPS rejection events cannot be quantified retrospectively; this is identified as a system limitation. Across both cohorts, a total of 900 timetabled sessions were conducted (412 sessions across two semesters for Year 1; 488 sessions across four blocks for Year 2). A total of 38,931 attendance records were processed (24,568 for Year 1; 14,363 for Year 2), with all 285 enrolled students recorded in the system. As no duplicate time-ins are permitted, each record represents one unique successful student time-in event.



Login screen | Time-In screen | Attendance monitoring screen

Figure 2: The Version 2.0 include the first page for login, second screen for student to time-in for each session, and monitoring screen for self-monitoring screen. The monitoring screen showing colour-coded real-time attendance percentages across the three tracking categories.

RESULTS

SmartTasjeel produced measurable improvements across three areas: efficiency, accuracy, and inclusivity.

Efficiency

Table 1 compares the three attendance methods across key operational dimensions. Per-session attendance processing time fell from 30 minutes (paper signatures) or 10 minutes (biometric queueing) to under 15 seconds per student. Weekly attendance percentage calculations fell from approximately 2 hours of manual computation to under 30 minutes of automated dashboard review per mid-block period. Post-session data processing, which previously required 1 hour for thumbprint data transfer, now happens in real time through automatic SharePoint synchronisation. Specifically, per-session processing time was reduced by approximately 99.2% relative to the paper-based baseline (from 30 minutes to under 15 seconds) and approximately 97.5% relative to the biometric-queue baseline (from 10 minutes to under 15 seconds). Across both cohorts, a total of 900 timetabled sessions were conducted (412 sessions across two semesters for Year 1; 488 sessions across four blocks for Year 2), with 38,931 attendance records processed in total (24,568 for Year 1; 14,363 for Year 2). All 285 enrolled students were recorded in the system, with each record representing one unique successful time-in event.

Accuracy and Data Granularity

The system substantially reduced the calculation errors inherent in manual percentage computation. The previous biometric system captured a maximum of 10 data points per student per week (twice-daily time-ins), whereas SmartTasjeel captures 20 to 25 data points per week through per-session tracking. It is a 2 to 2.5 times increase in granularity. Over two academic semesters of deployment, no attendance calculation errors were reported by coordinators during routine review, which involved cross-referencing the automated Excel dashboard against the absence-approval database at mid-block intervals. No formal independent audit was conducted; this statement reflects coordinator-reported operational experience. GPS verification reliably captured attendance at authorised venues while preventing remote fraudulent time-ins.

Feature	Paper-based	Biometric thumbprint	SmartTasjeel (GPS)
Technology	Manual sign-in sheets	Thumbprint scanner hardware	PowerApps + GPS geofence on student smartphones
Data capture	Manual (pen & paper)	Hardware-based scan	Automated GPS check-in via PowerApps
Processing time	~30 min/session	~10 min/session (queueing)	<15 sec/student; real-time SharePoint sync
Hardware cost	RM 0 (paper only)	RM 3,500-7,000 per unit	RM 0 (uses existing smartphones & M365 Education licences)
Student inclusivity	Universal	Excludes students with dermatological conditions affecting fingerprint recognition	Universal (smartphone-based)
Real-time monitoring	None	None	Live SharePoint dashboard with automated attendance percentage
Coordinator workload	High (~2 hr manual tallying/week)	Moderate (~1 hr data transfer/session)	Low (~30 min automated dashboard review per mid-block period)
Scale (Year 1 & 2)	Not applicable	Not applicable	900 sessions; 38,931 records; 285 students

Table 1: Comparison of attendance recording methods: paper-based, biometric thumbprint, and SmartTasjeel GPS-based system.

Inclusivity and Cost

SmartTasjeel also eliminated the hardware footprint of the biometric approach, which previously required approximately seven machines at RM500–1,000 each (RM3,500–7,000 total). The cloud-based architecture supports additional students at zero marginal cost. Students with dermatological conditions affecting fingerprint recognition, who were effectively excluded from biometric tracking, can now participate equally.

DISCUSSION

The progression from paper signatures to biometric systems to GPS-based automation reflects a sequence of solutions to successive limitations: first forgery prevention, then capacity and inclusivity, and finally per-session accuracy. SmartTasjeel addresses all three within a zero-cost platform.

The most operationally significant outcome is per-session capture, which the previous biometric system could not provide. Per-session data is what makes accurate attendance percentages possible, and accurate percentages are what make warning-letter and barring-from-examination workflows defensible. Without that granularity, the department had to rely on manual reconciliation, which was slow and error-prone.

The Version 2.0 self-monitoring feature is conceptually distinct from the administrative gains. Learning analytics dashboards that give students visibility into their own progress have been associated with improvements in motivation, engagement, and grades in higher education settings (Jayashanka et al., 2022; Ramaswami et al., 2023). The SmartTasjeel self-monitoring screen falls into this same category of intervention: it shifts students from passive end-of-block notification by attendance coordinator to active awareness of their percentage of attendance status percentage. Furthermore, the colour coding is designed to make the gap between actual and required attendance immediately readable. Whether this real-time awareness translates into changed attendance behaviour at our institution has not yet been formally evaluated, and that will be a direction for future work.

SmartTasjeel's architecture is transferable to any institution holding Microsoft 365 Education licences. It requires no premium connectors, no custom coding, and no specialised hardware beyond the mobile devices students already own. In our experience, the development required familiarity with the Microsoft Power Platform but not formal programming expertise. A lecturer with applied IT skills working alongside academic coordinators was sufficient. We acknowledge that this observation is based on a single development team and would benefit from independent replication in other institutional contexts. The approach is consistent with cost-effective digital transformation strategies described for tertiary education

(Althubaiti et al., 2022; Truong & Diep, 2023). These studies provide a worked example of how those general principles can be translated into a functioning operational system, particularly for institutions operating under resource constraints.

SmartTasjeel has several limitations. The application requires a smartphone or tablet (GPS is unavailable on most laptops) and an active internet connection. The coordinator workflow still involves manual SharePoint interaction for absence approvals; a dedicated coordinator-facing interface remains a future development priority. Timetable changes not updated in SharePoint can produce inaccurate session records, though this is a workflow coordination rather than a technical issue. Critically, the data presented are operational rather than experimental: formal evaluation of user satisfaction and the behavioural impact of the self-monitoring feature on attendance are needed and represent clear priorities for further research.

On privacy, SmartTasjeel captures location only at the moment of time-in rather than continuously, limiting data minimisation concerns relative to continuous tracking approaches (Durodolu et al., 2026). All data are stored within institutional IIUM Microsoft 365 accounts under the same governance framework. GPS coordinate data is comparatively less sensitive than biometric identifiers and no external or third-party accounts are used. Future deployments should communicate these governance arrangements to students in advance and establish a formal data retention schedule.

CONCLUSION

SmartTasjeel demonstrates that GPS-based automated attendance tracking can be implemented for medical education using only free Microsoft 365 Education licences, with no premium connectors, no custom code, and no additional hardware purchase. The system reduced per-session processing time by approximately 97.5–99.2% (depending on baseline), substantially reduced manual calculation errors based on coordinator review, and enabled per-session tracking, which is essential for early identification of at-risk students and for defensible warning-letter and barring workflows. Its zero-cost development, scalability, and inclusivity make it especially relevant to other medical and health education institutions operating under resource constraints. Future work should formally evaluate whether the real-time self-monitoring feature changes student attendance behaviour and academic performance.

ACKNOWLEDGEMENT

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ETHICAL CONSIDERATIONS

SmartTasjeel was developed and deployed as an operational attendance management system within the Department of Basic Medical Sciences, Kulliyyah of Medicine, IIUM. The system processes attendance data that the department already collected through previous paper and biometric systems for the same operational purpose. No experimental procedures were conducted on students, no human subjects research was undertaken, and no identifiable personal data beyond standard institutional attendance records was used. This report describes the system's design and operational outcomes; formal ethics approval will be sought separately for any future study evaluating student behavioural or learning outcomes attributable to the system.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the authors used Claude (Anthropic) to assist with language editing, citation verification through the Scite AI and Consensus integrations, and formatting alignment to the journal template. The authors subsequently reviewed, revised, and approved all content and accept full responsibility for the final manuscript.

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