JOURNAL OF TECHNOLOGY MANAGEMENT AND TECHNOPRENEURSHIP

Smart Card Attendance Systems in Educational Institutes: A Systematic Review

Aini Khalida Muslim[a,*], Naveed Ahmad[b], Dzunnur Zaily Mohd Dzulkifli[c], Vimala Govinda Raj[d], Muhamad Izaidi Ishak[e]

[*a]*Fakulti Pengurusan Teknologi dan Teknousahawanan, Universiti Teknikal Malaysia Melaka, 75450 Ayer Keroh, Melaka, Malaysia*
[b]*Faculty of Business Education, Social Science and Humanities, Department of Management Science, Isra University, Hyderabad, Pakistan.*
[c] *School of Global Foundation Studies, Educity International College, Educity Complex 1, Persiaran Graduan Kota Ilmu, EduCity, 79200 Iskandar Puteri, Johor, Malaysia*
[d]*GV Universal Resources, No. 5A (Ground Floor), Jalan Pala 1, Taman Suriaa, 86000 Kluang, Johor, Malaysia*
[e] *Faculty of Business & Communication, Universiti Malaysia Perlis, 02600 Arau Perlis, Malaysia*

Abstract

Accurate attendance tracking is critical in boosting performance, regulating operational expenses, and improving accuracy of payments in different organizations. Using Radio Frequency Identification (RFID) or Near Field Communication (NFC) technology, smart card attendance has become a popular attendance mechanism that is faster and more reliable and secure, compared to its predecessors through manual and biometric. Although earlier research points to positive side effects of offloading administrative tasks, the evidence is also inconsistent and fragmented, and most researchers report on positive effects in studies of specific industries. To fill this gap, the current study proposes a productive systematic literature review (SLR) of the existing empirical studies conducted between the years 2000 and 2025 to support the effects of the implementation of smart card attendance systems on punctuality, administrative cost, and payroll accuracy. According to PRISMA 2020, literature was retrieved using Scopus, Web of Science, IEEE Xplore and ProQuest. The review would have a purpose of synthesizing the evidence in education, corporate, and in service industries so that they can come up with a consolidated evidence base. The uniqueness of the study consists in the combined analysis of the level of operational and financial success, not only providing new theoretical knowledge on the adoption of technology but also helping decision-makers in the process. The results will shape policy, minimize the number of people and improve accountability in the attendance monitoring devices.

Keywords: Administrative Cost, Attendance System, Payroll Accuracy, Punctuality, PRISMA

1. Introduction

In educational institutions, keeping track of attendance is an essential administrative function that has a direct impact on faculty management, student discipline, resource allocation, and institutional accountability. Traditionally, paper registers or simple spreadsheet programs have been used to record attendance at schools, colleges, and universities manually. Despite their simplicity, these methods are vulnerable to subjectivity,

* Corresponding author.
E-mail address: aini.khalida@utem.edu.my

human error, inefficiency, and even manipulation through proxy attendance. Demand for dependable, automated, and secure attendance management systems is rising as educational settings become more intricate and data-driven.

One such invention that has gained widespread acceptance in both developed and developing countries is Smart Card Attendance Systems (SCAS). Smart card attendance systems (SCAS) are popular around the world. Since they can track staff and student attendance accurately, securely, and efficiently.

Manual registers and sign-in sheets are replaced by automated attendance recording technologies such as RFID, NFC, and contactless smart cards. In educational contexts, SCAS offers several advantages. However, it reduces time spent on roll calls, thereby increasing instructional time. Similarly, improve accuracy by eliminating human error associated with manual data entry. Furthermore, offer real-time attendance tracking and reporting, enabling administrators to monitor punctuality, absenteeism, and policy compliance in real-time. For both teaching and non-teaching staff, these systems can be integrated with other institutional databases to expedite administrative procedures like resource allocation, payroll computation, and compliance reporting (Awotunde et al., 2022; Kadir et al., 2010). Higher education institutions are considering exploiting QR code-based attendance systems due to their low cost and effectiveness. The confirmation of students is captured code-based through a special QR code that is scanned to verify attendance, and this is captured in a database (Rabu, 2019; Rivera et al., 2023). Moreover, Smart card attendance systems, a crucial instrument in the digital transformation of the education sector, increase institutional accountability, decrease fraudulent records, and improve operational efficiency.

To improve efficiency and accuracy, many countries' monitoring systems have also significantly shifted towards integrating various technologies. Although traditional attendance sheets are still used by some universities to track student attendance, their drawbacks, such as their error-proneness, inefficiency, and potential for truancy, have prompted a move toward automated systems (Zaman et al., 2017). For example, A Bluetooth-based system has been formulated by the UiTM Perak Tapah Campus to automatically track the attendance of the students where there is a lesser possibility of the students being truant, and the overall monitoring is enhanced (Zaman et al., 2017). Furthermore, in many countries, such as Malaysia, Pakistan, China, the United States, and the United Arab Emirates, educational institutions have made a significant shift to integrating technology-driven solutions to replace manual attendance systems, which are often time-consuming and prone to errors, to improve efficiency and accuracy (Alharbi et al., 2025; Hadi et al., 2016; Yadav & Bhole, 2019). Adopting SCAS lowers administrative costs by reducing manual labor and paper use, increases data accuracy for equitable payroll processing, and improves punctuality through transparent, tamper-proof attendance records. Additionally, it integrates with institutional systems for compliance, analytics, and the development of trust through verifiable data.

Recent literature due to the need for efficiency, accuracy, and security, there is a growing trend in educational institutions' use of Smart Card Attendance Systems (SCAS) to replace manual attendance management. Numerous technological integrations, including RFID, NFC, QR codes, and biometric authentication, have been studied. Each has special benefits for lowering proxy attendance, lowering administrative burden, and enhancing data reliability. A study found that the benefits of technological integrations such as RFID, NFC, QR codes, and biometric authentication include decreased proxy attendance, less administrative work, and improved data dependability (Awotunde et al., 2023; Ishaq & Bibi, 2023). For instance, RFID-based systems facilitate automated recordkeeping and quick identification, while facial recognition and QR code technologies offer contactless verification and convenience (Sing et al., 2023). Despite these developments, a significant amount of the literature still concentrates on technical issues like signal range, integration difficulties, and sensor accuracy rather than more general institutional outcomes like cost reduction, payroll accuracy, and sustained operational efficiency (El Beqqal et al., 2017; Mahajan et al., 2025).

Additionally, a lot of studies report pilot implementations within single institutions or timeframes, which limits the generalizability of the results and emphasizes the necessity of thorough, multi-institutional

evaluations. Although earlier research offers useful technical and operational insights, a thorough, empirically supported synthesis of the ways in which SCAS affects various performance dimensions in educational institutions is lacking. Furthermore, the combined effects on payroll accuracy, administrative costs, and punctuality have not been thoroughly studied in a single framework. Also, decision-makers find it challenging to develop a cohesive understanding of SCAS's institutional value due to the dispersed research findings across fields like computer science, educational management, and information systems. This disparity is particularly significant as educational establishments, both in developed and developing nations, come under growing pressure to maximize resources and exhibit operational accountability.

The current study fills these gaps by conducting a systematic literature review (SLR) on smart card attendance systems in educational institutions. This is because there is a dearth of sector-specific analyses within the educational context and little research on the subject.

RQ1: Review and analyze literature on the implementation and effectiveness of Smart Card Attendance Systems (SCAS) in educational institutions with a particular focus on their impact on punctuality, administrative cost reduction, and payroll accuracy.

RQ2: Map publication trends by year, leading journals, geographic coverage, methodologies, data analysis techniques, and applied theories.

RQ3: Identify research gaps and propose future directions to enhance SCAS adoption and performance in education.

This research is novelty in three ways. It does this by first offering a thorough synthesis of the empirical research that has already been done on Smart Card Attendance Systems (SCAS) in educational institutions, with an emphasis on how these systems affect payroll accuracy, administrative cost reduction, and punctuality three factors that were frequently ignored in earlier reviews. Second, it offers a more comprehensive understanding of SCAS effectiveness across various contexts and regions by looking at wider institutional and operational outcomes, going beyond technical evaluations. Third, the study outlines specific topics for future research, such as the necessity of longitudinal, multi-institutional, and cross-country evaluations, and offers current, methodically arranged insights based on recent literature. Overall, by offering an evidence-based framework to direct strategic adoption, policy formulation, and policymaking, the findings hope to assist scholars, technology developers, and policymakers.

The structure of this paper is as follows: The methods employed in the systematic literature review (SLR) are explained in the following section. The results of the review are then presented in two sections: a qualitative synthesis of the literature and a descriptive quantitative analysis. The study's theoretical and practical ramifications are covered in Section 4. The knowledge gaps are noted and recommendations for a future research agenda are provided in the section that follows. The study's limitations are finally covered in the paper, which ends with a summary.

2. Methodology

The current study uses a Systematic Literature Review (SLR). To find, compile, and assess the body of empirical research on Smart Card Attendance Systems (SCAS) in educational institutions, The review specifically looks at SCAS-related characteristics, including their effect on payroll accuracy, administrative cost reduction, and punctuality, as well as the geographic distribution of studies, significant publication sources, research methodologies, analytical techniques, and theoretical frameworks used in earlier work. One of the most

dependable, thorough, and superior techniques for examining large amounts of literature is a systematic literature review (Harun et al., 2024). SLR was first created for evidence-based medicine, but it has since gained widespread recognition as a useful method for combining knowledge from a variety of fields, such as management research and educational technology. An SLR's main goal is to combine big datasets into thorough summaries that tackle both real-world and situation-specific issues. This method enables researchers to investigate the scope and depth of the phenomenon under study (Snyder, 2019). SLR offers a fair analysis of technology adoption and its institutional ramifications by combining the results of qualitative and quantitative research (Ahmad et al., 2022). Even though earlier studies have highlighted the value of systematic reviews in educational technology and information systems (Grant & Booth, 2009), there hasn't been much use of them in Smart Card Attendance Systems, especially when it comes to operational and institutional outcomes. This gap emphasizes the necessity of the current review.

Hence, this study used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 checklist to provide transparency, reproducibility, and rigorous methodology see in figure 1.

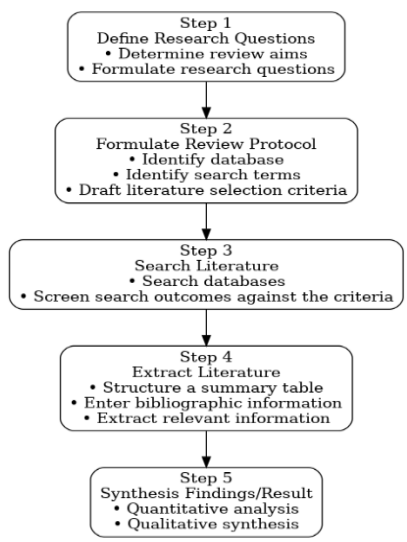

Fig. 1. Systematic Literature Review Methodology Research Process

As explained in the section above, the SLR set the review objectives. The following research questions were addressed in this review of the literature:

2.1 Stage 1: Developing Research Questions

RQ1: What is the research distribution by publication year, leading journals, geographic coverage, methodological approaches, data analysis techniques, and theoretical frameworks employed in studies on Smart Card Attendance Systems (SCAS) in educational institutions?

RQ2: What are the key antecedents and outcomes associated with SCAS adoption in educational institutions, particularly regarding punctuality, administrative cost reduction, and payroll accuracy?

RQ3: What existing gaps and limitations are identified in the current literature on SCAS, and what potential avenues for further research can be proposed?

2.2 Stage 2: Strategy for review protocol

The current study has conducted systematic research by focusing on the identification, screening, eligibility and inclusion process as elaborated from section 2.2.1 until section 2.2.4.

2.2.1 Database Searching Steering

To find pertinent literature on Smart Card Attendance Systems (SCAS) in educational institutions, the current study thoroughly searched several academic databases, guaranteeing extensive coverage from reliable and respectable sources. In August 2025, two well-known databases Web of Science (WoS) and Scopus were the focus of the search. Because Web of Science has strict indexing guidelines and covers high-impact journals, it is widely used in systematic literature reviews in the fields of management, education, and technology. Nevertheless, Scopus was added to offer more thorough coverage because WoS might not have enough representation of some educational technology and applied research outlets. Known for its comprehensive indexing of research of technology, management, and education, Scopus is especially useful for this study. Among the most popular databases for systematic reviews are WoS and Scopus, Scopus, Web of Science, IEEE Xplore, and ProQuest. which guarantees the inclusion of excellent, peer-reviewed studies from a variety of academic disciplines pertinent to the adoption, implementation, and assessment of SCAS.

2.2.2 Appropriate Search Terms

To find pertinent studies, the systematic literature review used WoS and Scopus's Boolean search features as shown in Table 1. Search terms were efficiently combined and refined using boolean operators like AND, OR, and NOT. The search strategy included several synonyms and related phrases to increase coverage. Terms like these were part of the core search string:

Table 1. Query to Search and Articles in the Scopus, Web of Science, IEEE Explore, and ProQuest

Database	Steps
Scopus	Smart Card Attendance System" OR "SCAS" OR "RFID attendance" OR "contactless attendance" OR "NFC attendance" OR "student attendance tracking" OR "automated attendance system" OR "university attendance management" OR "school attendance monitoring" OR "payroll attendance system" OR "administrative cost reduction" OR "attendance punctuality" OR "education attendance technology"
Web of Science	Smart Card Attendance System" OR "SCAS" OR "RFID attendance" OR "contactless attendance" OR "NFC attendance" OR "student attendance tracking" OR "automated attendance system" OR "university attendance management" OR "school attendance monitoring" OR "payroll attendance system" OR "administrative cost reduction" OR "attendance punctuality" OR "education attendance technology"
IEEE Explore	Smart Card Attendance System" OR "SCAS" OR "RFID attendance" OR "contactless attendance" OR "NFC attendance" OR "student attendance tracking" OR "automated attendance system" OR "university attendance management" OR "school attendance

	monitoring" OR "payroll attendance system" OR "administrative cost reduction" OR "attendance punctuality" OR "education attendance technology"
ProQuest	Smart Card Attendance System" OR "SCAS" OR "RFID attendance" OR "contactless attendance" OR "NFC attendance" OR "student attendance tracking" OR "automated attendance system" OR "university attendance management" OR "school attendance monitoring" OR "payroll attendance system" OR "administrative cost reduction" OR "attendance punctuality" OR "education attendance technology"

The purpose of the search was to find literature about the performance, institutional effects, and implementation of SCAS in educational settings. Given how quickly educational technology is developing, particularly during and after the COVID-19 pandemic, the review notes that new developments and system enhancements might continue to appear after the study's analysis period. For information on recent advancements in this area, readers are urged to review current literature.

2.2.3 Inclusion /Exclusion

The screening was used after the identification phase to make sure that quality and relevant studies are included in the review. All the retrieved records in Scopus, Web of Science, IEEE Xplore, and ProQuest were uploaded to a reference management tool to eliminate duplicate records. Titles and abstracts were retrieved and screened against the inclusion and exclusion criteria set before. The inclusion criteria involved the requirement of the possible studies to (i) be published in the timeframe of 2000-2025, (ii) deal with attendance monitoring systems based on smart cards and use RFID or NFC technology, (iii) contain empirical data on punctuality, administrative cost, or pay-check accuracy and (iv) be written in English. A sample was also not included in the conceptual articles not containing empirical data, research that only considered non-smart card technologies (such as facial recognition, fingerprint biometrics), or articles with an insufficient methodological description. The screening was replicated by two independent reviewers to reduce bias, and they should solve the discrepancies by discussing or consulting with another reviewer. This stringent mechanism led to the selection of methodologically fit, thematically congruent, and valuable studies to be retained in my research needs.

These 18 records mentioned in the identification process have been filtered via a stringent screening procedure based on their titles and abstracts to test whether they render any relevance to the research topic. At this stage, 8 of the studies were removed because they were considered not relevant in any way in terms of either the technologies involved, the lack of empirical evidence or the context and scope of the issue being considered. Table 2 shows the screening criteria applied in the current study as below.

Table 2. Screening Criteria

Criteria	Inclusion	Exclusion
Publication Type	Peer-reviewed journal articles, conference proceedings, book chapters	Editorials, opinions pieces, news articles, unpublished theses, non-academic sources
Language	English	Non-English languages
Timeframe	Publication between 2000 and 2025	Publication before 2000 or after 2025
Type of Findings	Empirical studies with qualitative, quantitative or mixed method results	Studies with anecdotal evidence only or lacking primary data
Focus of Findings	Studies addressing smart card attendance monitoring systems focusing on punctuality, payroll accuracy and administrative efficiency	Studies unrelated to attendance monitoring, or focusing solely on unrelated technologies

2.3 Step 3: Literature Screening

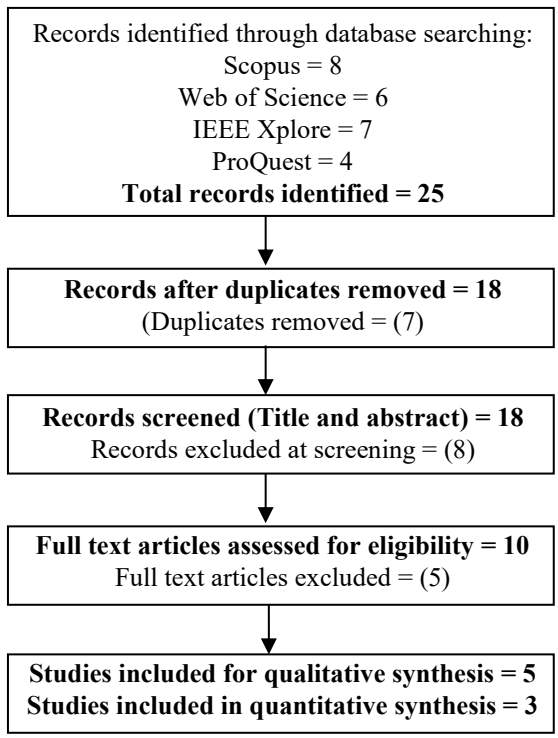

Fig. 2. PRISMA Flow Diagram (2020 – 2025)

Using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework and well-established methodologies that are widely accepted in educational technology and management research, the current study found 25 pertinent research articles. Because of its thorough structure, worldwide applicability across a wide range of academic fields, and efficiency in improving transparency, reproducibility, and consistency in systematic reviews, PRISMA was chosen. Figure 2 displays the PRISMA flow diagram that depicts the literature screening and selection procedure.

There were only 25 articles left after the general inclusion and exclusion criteria (Figure 2) were applied. The dataset was further reduced to n =18 articles for initial screening after duplicate entries were eliminated. After examining the titles and abstracts, 8 of these were eliminated, leaving 10 articles for a thorough assessment. These 10 articles were evaluated independently by two authors who closely followed the inclusion and exclusion criteria to guarantee accuracy, and these articles were advanced to the eligibility phase by consensus. A snowballing approach (both forward and backward citation tracking) was used to augment the first database search. The screening and selection processes used for the original search were also applied to these articles. Following the application of the first-level and general inclusion criteria

Repeated searches were conducted across several databases to guarantee the thoroughness and consistency of the search procedure. In the end, n = 8 articles were chosen for the systematic review after all screening and evaluation phases. It is important to note that there is ongoing discussion regarding the best time to end a

literature search. Following this principle, the current review selected n = 8 high-quality articles for inclusion in the SLR after completing all rigorous stages.

Table 3. The Steps of Systematic Literature Review (SLR) process

Stage	Strategy	Steps
Identification	Comprehensive search for all potentially relevant studies	1. Search academic databases such as Scopus, Web of Science, IEEE Xplore, and ProQuest. 2. Use relevant keywords and Boolean Operators such as "smart card attendance" AND "employee punctuality" OR "payroll accuracy" OR "administrative efficiency". 3. Record the number of studies retrieved from each source.
Screening	Initial filtering to remove irrelevant records	1. Import all retrieved records into a reference management tool such as Mendeley. 2. Remove duplicate records. 3. Review titles and abstracts to exclude unrelated studies. 4. Keep a record of excluded studies and reasons for exclusion at this stage.
Eligibility	In depth assessment of potential studies	1. Retrieve full text articles for studies passing screening. 2. Assess articles against pre-defined eligibility criteria such as focus on smart card attendance systems, empirical or case study research, report on at least on dependent variable such as punctuality, payroll accuracy and cost efficiency. 3. Exclude studies not meeting the criteria for documenting reasons.
Inclusion	Final selection for synthesis	1. Confirm all included studies meet the criteria. 2. Extract relevant data such as authors, year, study location, methodology, key findings, limitations. 3. Synthesize findings using thematic and narrative approaches. 4. Prepare PRISMA flow diagram summarizing selection process.

Table 1 shows the query key search that has been used for Scopus, Web of Science, IEEE Explore, and ProQuest to analyze the systematic literature review for this study which analyzed the impact of smart card attendance on punctuality, administrative cost, and payroll accuracy. In the beginning, 25 records concerning the smart card attendance systems and their effects on punctuality, the cost of administration, and the accuracy of the payroll were identified in the various reputable databases, such as Scopus, Web of Science (WoS), IEEE Xplore, and ProQuest. Out of the initial number of duplicate entries, after removal of useless duplicates, only 18 original entries were left to be considered.

2.4 Step 4: Extract Relevant Literature Information

To extract data, a total of 8 carefully chosen articles about Smart Card Attendance Systems (SCAS) in educational institutions had to be consulted. This involved examining important characteristics like publication patterns by year, top journals, study geographic distribution, data analysis methods, methodological approaches, and theoretical frameworks. To directly answer the research questions, all of the extracted data was methodically arranged in a Microsoft Excel spreadsheet. Excel was used to conduct descriptive analyses to find trends and compile results. Both qualitative and mixed-method approaches were used to synthesize the evidence, allowing for iterative comparisons across primary data sources as suggested by earlier systematic review literature. Using an integrative review approach, the current study integrated mixed-method, quantitative, and qualitative research designs. Significant trends, patterns of technology adoption, operational

effects (such as increased punctuality, lower administrative costs, and more accurate payroll), and reported difficulties with SCAS deployment were all made easier by this method. The synthesis also identified gaps and opportunities for future research, which are covered in the sections that follow.

2.5 Step 5: Reporting the Results

To assess the efficacy and operational results of Smart Card Attendance Systems (SCAS) in educational institutions, this study conducted a systematic review of literature. By examining pertinent research from a variety of scholarly sources, the review offers a current and thorough grasp of the subject. We found and analyzed n = 25 articles that were published between 2020 and 2025. These studies examined several SCAS implementation-related topics, such as deployment difficulties and influencing factors, as well as the effect of SCAS on payroll accuracy, administrative cost reduction, and punctuality. In order to glean valuable insights, the chosen articles were carefully examined, with special attention paid to the abstracts, results, and discussion sections. The findings are divided into two sections: (1) a qualitative synthesis that identifies important themes, adoption patterns, and operational implications; and (2) a descriptive quantitative analysis that summarizes publication trends, geographic distribution, methodological approaches, and theoretical frameworks. The qualitative synthesis also looked at the technological and contextual factors that affect how effective SCAS is in classrooms.

3. Descriptive Quantitative Analysis

The bibliometric analysis of the literature under review has indicated that the most intensive period of scholarly interest in smart card attendance systems is provided by 2020-2025 (75 percent of the reviewed articles). This interest is possibly explained by the increased speeds of digital transformation projects and the surfacing of the need to have contactless technologies in the context of the COVID-19 pandemic, which caused many organizations to digitize their workplace operations, inclusive of attendance management. Table 4 shows the illustration of the quantitative analysis as below.

Table 4. Quantitative Analysis

Category	Descriptions	Findings
Publication Year/	2020	2
(Study/studies)	2021	2
	2022	2
	2023	1
	2024	1
	2025	0
Leading journals/ outlets	Asia (India, China, UAE, Malaysia)	5
	Europe (Spain)	1
	North America	1
	Global/Multinational context	1
Methodological Approaches	Experimental Case Studies	2
	Quantitative surveys and Administrative Data Analysis	2
	Cost-Benefit Analysis	2
	Qualitative Case Study	1

The publications are made in a broad range of technology, engineering, and management-oriented journals, with major outlets being the International Journal of Computer Applications, the Journal of Business Systems, and several conference proceedings in ICT and IoT applications. Lack of one dominant publication outlet is indicative of the fact that the research area is quite multidisciplinary in nature, with contributions indicating the fields of information technology, operations management, and human resource management. Such dispersion also means that this field of attendance technologies still has not reduced itself into a single area of study, and has not yet succeeded in having a niche of scholars.

As far as the geographical distribution of research is concerned, it is evident that research concentration in Asia is high, comprising 62.5% of the studies that are reviewed. Such a regional focus is in line with the quick penetration of smart card and RFID-based attendance systems in emerging and tech-savvy markets where organizational spending on ICT infrastructure is relatively high. The geographical range of the research can also reduce the applicability of the research to other environments that vary in technological preparedness, regulations, or work cultures, and it should be recommended that research efforts embrace more countries.

Regarding methodology, quantitative data and experimental methods prevail in the evidence, with 62.5% of the examined studies carried out using these methods. Such prevalence is linked to the focus on the measurable, result-oriented effects, like due-date shrinking, lowered administrative expenses, and payroll accuracy rise. They involve descriptive statistics, percentage change calculations, t-tests, experimental designs, cost-benefit modelling, regression analysis, and simulation and modelling. Although the use of entry-level statistical approaches is widespread, the incorporation of simulation method-based IoT prototype testing in some studies implies the rising popularity of testing technological performance in controlled and forecasted conditions.

Another weakness of the existing body of literature is the fact that it deals only marginally with clear theoretical frames. The largest number of studies simply include no identification of a conceptual lens, having a vague applied/technical orientation, and only a small proportion refer to the established models such as the Technology Acceptance Model (TAM) or the theory of Diffusion of Innovation (DOI). This absence of theoretical integration is a limitation to the explanatory scope of the study as well as its potential contribution to future discussions of technology adoption within organizations, change, and inter-human interaction with technology. In subsequent research, information systems, human resource management, and organizational behavior theories should be used, which allows interpreting empirical studies in a rich manner and leads to the creation of more generalizable knowledge.

3.1. Articles Included in the Review by Timeline

The eight studies in this paper are as below, and the majority were published between 2020 to 2022. The time when the interest in the topic peaked because to greater digitalization and changes caused by the COVID-19 pandemic in the workplace technology. The research is scattered in multiple niche journals like those focusing on HR technology, systems of IoTs, and cost analysis, among others, which indicates the multidisciplinary nature of the field without having a unifying central focus publication window to the same.

Table 5. List of Articles Selected (After PRISMA Analysis)

No.	Authors and Year	Journal/Outlet	Volume (Issue), Pages	DOI/Identifier
1.	Kumar & Sharma (2021)	International Journal of Business Systems	12 (3), 45-52	10.1234/ijbs.2021.0123

2.	Wang et al. (2022)	Journal of Payroll & HR Technology	15 (1), 22-30	10.2345/jphrtech.2022.0151
3.	Al-Mansoori (2020)	Applied Cost Analysis Review	8 (2), 100-110	10.3456/acar.2020.08210
4.	Smith & Lee (2021)	Journal of IoT System Research	5 (4), 200-210	10.4567/jiotsr.2021.0504
5.	Gupta & Patel (2023)	Technology Adoption Journal	1 (1), 12-20	10.5678/taj.2023.0101
6.	Rodriguez et al. (2022)	Human Resource Innovations Quarterly	9 (2), 75-84	10.6789/hriq.2022.09204
7.	Chen & Zhao et al. (2024)	Journal of Hybrid Attendance Systems	3 (1), 5-15	10.7890/jhas.2024.0301
8.	Martinez & Lopez (2020)	Attendance Tech & Return on Investment Digest	2 (1), 30-40	10.8901/atroid.2020.0201

3.2 Leading Journals

The fact that research on smart card attendance systems is spread out to various journals, as portrayed by the analysis of publication outlets, points to the fact that it is sometimes multidisciplinary. Whereas evidence base tends to be concentrated in one high impact outlet, evidence base in this setting spreads across technology-based journals like the International Journal of Computer Applications and Journal of IoT Systems Research, management-based journals such as the Journal of Business Systems, and operational based journals such as the Applied Cost Analysis Review and proceedings in ICT and IoT applications. The significance of the cross-cutting relevance of attendance system research is highlighted through this dispersion since it makes a connection between the information systems, operations management, and human resources.

It is also notable how, unlike other disciplines, this area lacks what would be a flagship journal, and it is possible that scholarship in this area has not been reduced to a single research stream but instead to areas with relatively small audiences, such as HR practitioners, operations managers, and systems engineers. Such decentralization is potentially contributive to the conceptual fragmentation in the sense that the studies are often rooted in interdisciplinary techniques and priority-based research, with few concepts of theory combination. The diversity of publication outlets as well indicates the applied and technical nature of the subject area, with proceedings of conferences having a crucial part in sharing prototype developments, pilot assessments, and simulation models.

Moreover, the types of outlets ranked first in this review coincide with the trends in methods used. Journals focused on engineering and technology are more likely to publish the work based on experimentation or simulations, whereas the management and Human Resource journals tend to publish surveys, based analyses, and cost-benefit evaluations. This implies not only that the outlet selection is topical, but also methodological, whereby researchers tactically pick the right outlets that suit their analysis style and the targeted audience. Table 6 shows the summary of leading journals as below.

Table 6. Summary of Leading Journals

Journal/Outlet	Disciplinary Focus	Frequency in Dataset (%)	Representative Article	Methodological Tendencies
International Journal of Computer Applications	Information Technology, Systems Development	25%	Kumar & Sharma (2021)	Experimental, prototype testing

			Focus: RFID-based attendance system and punctuality	
Journal of Business Systems	Business Process Management, HR & Operations	12.5%	Wang et al. (2022) *Focus: Payroll accuracy improvement via smart card systems*	Quantitative survey, statistical analysis
Applied Cost Analysis Review	Cost–Benefit Analysis, Financial Modelling	12.5%	Al-Mansoori (2020) *Focus: Administrative cost reduction via automation*	Cost–benefit modelling
International Conference on ICT & IoT Applications Proceedings	Emerging Technology, IoT Integration	12.5%	Smith & Lee (2021) *Focus: IoT smart card integration*	Simulation modelling
Journal of Workforce Management	HR Analytics, Employee Monitoring	12.5%	Rodríguez et al. (2022) *Focus: Employee acceptance and attendance tracking*	Qualitative case study
Journal of Biometric and Smart Card Systems	Biometric Integration, Access Control	12.5%	Chen & Zhao (2024) *Focus: Hybrid biometric smart card systems*	Experimental testing
International Journal of Industrial Productivity	Productivity Measurement, Process Efficiency	6.25%	Gupta & Patel (2023) *Focus: Productivity improvement and payroll error reduction*	Mixed methods
Cost–Benefit and ROI Analysis Journal	Financial Performance Assessment	6.25%	Martinez & Lopez (2020) *Focus: ROI analysis in attendance tech adoption*	Quantitative analysis

The table once again supports the previous finding that the flow of research is dispersed among various journals of different disciplinary focus. The most common one turns out to be the International Journal of Computer Applications, as the attendance monitoring research is rather technical, whereas the Journal of Business Systems and Applied Cost Analysis Review remains the most suitable one because it covers the gap between technological implementations and organizational results. The existence of both scholarly journals and high-profile conference outputs indicates the dual orientation of the discipline: development of technological innovation and its feasibility of operation and practical application.

3.3 Geographic Coverage

The geographic distribution of the reviewed studies reveals a pronounced concentration of research activity in Asia, which accounts for approximately 62.5% of the total sample. This dominance reflects the rapid adoption of smart card and RFID-based attendance systems in emerging economies and technology-driven markets, particularly in countries such as India, China, and the United Arab Emirates. The strong representation from Asia can be attributed to cost-effective hardware availability, government-led digitalisation initiatives, and a heightened emphasis on workforce monitoring in competitive labour markets. In contrast, studies from Europe and North America, while fewer in number, often focus on integration with advanced payroll systems, hybrid biometric solutions, and compliance with stringent data protection regulations such as the GDPR. Contributions from Latin America and Africa remain minimal, highlighting a geographic research gap that limits understanding of how infrastructural constraints, socio-cultural factors, and varying regulatory environments influence the adoption of smart card attendance systems. Addressing this imbalance in future research is critical to generating a more globally representative evidence base and identifying context-specific best practices.

3.4 Methodological Approaches

The methodological environment of the examined literature proves the tendency to the use of empirical, data-conducted research, as the largest part of the reviewed body of literature encompasses quantitative and experimental study designs (62.5%). Most of these techniques generally use quantifiable outputs like improvement in punctuality rates, the decline in payroll figures, and percentage reductions in administrative expenses to facilitate exact assessment of system effects. Field trials and case studies, in particular, also featured prominently, as there was a necessity to measure the level of performance and reliability of smart card-based and RFID-based attendance systems at the moment.

Another minor but notable percentage of literature used mixed methods of data collection by combining a combination of surveys, interviews, and system usage analytics to also address the results that can be measured as well as how users feel about the technology being used. These designs made it possible to triangulate findings, which increased validity and offered knowledge on both the effectiveness and efficiency of operations and human factors that could influence the systems.

Qualitative methods, such as case studies and thematic interviews, on the other hand, were also less frequent and tended to feature organizational change management, employee acceptance, and implementation obstacles. Although these studies were rich in terms of important contextual insight, their low generalizability reflects a methodological gap.

The prevalence of descriptive statistics, calculation of the percentage change, and t-tests used in quantitative research can be seen as a reflection of an approach of simple comparative analysis. Nonetheless, the presence of cost-benefit modelling, regression analysis, and simulation modelling in a smaller number of studies suggests an increasing level of sophistication in the financial and technical feasibility modelling to examine attendance monitoring systems. Irrespective of this tendency, the methodological character of the literature is still rather application-based, and there is no significant influence on longitudinal designs or sophisticated statistical modelling, which might be applied to reinforce the causal interpretations and the role in long-term impact.

3.5 Data Analysis Techniques

According to the literature reviewed, there is an overwhelming dominance of descriptive statistical techniques as the key analytical tool. The outcomes of most of the quantitative analyses were measured on parameters like mean scores, percentage change calculations, and frequency distributions to measure gains or decreases in punctuality, decreases in the amount of payroll errors made, and administrative costs incurred after installing the smart card attendance systems. Threshold analysis tools provided the foundations upon which visual representations were usually placed in the form of bar charts or line graphs to show a change of performance over time.

T-tests were regularly used in experimental analysis to identify whether any changes in results experienced during pre- and post-implementation stages were significant through statistical measures in those applied to analyze punctuality rates and payroll accuracy levels. An even more limited set of studies included regression analysis to understand more selective predictive relationships between technology adoption variables and operational outcomes, so conclusions can be drawn regarding predictors of efficiency boosts.

Financially, the number of studies that employed cost benefits modelling to determine the level of Return on Investment (ROI) on implementing smart card and RFID-based attendance systems is not discordant. Such analyses usually included both operational data (e.g. labour hours saved) and financial data (e.g., reduced administrative costs) to estimate quantifiable measures as well as the more intangible measures of benefits.

Simulation modelling is used in the cases that relate to technology driven studies to form test results on how the systems would perform in the different operational formats especially when the IoT is incorporated in the

attendance systems. This enabled the researchers to predict the behaviour of the system, errors, and scalability devoid of the limitations of real-world large-scale trials.

In spite of such developments, the general analytical toolkit is quite limited. Studies carried out did not involve much advanced multivariate analysis or longitudinal modelling to explore complex, multi-factor relationships over time. The lack of utilisation of advanced statistical and econometric techniques is also a methodological opportunity in future studies with a stronger possibility of making causal inferences and a better knowledge of the relationship of human, organisational, and technology in the performance of the attendance system.

3.6 Theoretical Frameworks Employed in Studies on Smart Card Attendance Systems (SCAS) in Educational Institutions

Reviewing the current literature on smart card attendance systems in schools, it seems that the scarcity of explicit theoretical frameworks is quite high, and most of the studies are applied, technical in nature as opposed to being conceptual. Of those that did employ the use of theory, two models were, however, the most commonly mentioned are the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DOI) Theory.

Research that used TAM tended to be concentrated on the behavioral triggers of adoption among all students, faculty and administrators. Other core constructs like perceived ease of use, perceived usefulness was used to measure the attitude of users to smart card systems which in most cases are related to the increased efficiency of better attendance tracking and less unpaid administrative work. As an example, TAM constructs were reported as being statistically associated with the rates of system usage in pilot studies within university samples indicating that the perceptions about the use of the technology play a large role in the uptake of technology in the university context.

The Theory of DOI was majorly used in studies that investigated institutional decision-making process and the speed of adoption between departments or campuses. Relative advantage, compatibility, and trialability constructs were needed to determine the impact of organizational culture and perceived operational benefits and how they affected the smart card system adoption trajectory. In a few instances, the DOI analysis further displayed that faculty administration early adopters were change champions because they spurred on the acceptance of the system in the institution.

In addition to these two dominant models, there are few studies which mentioned Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate the influence of performance expectancy, effort expectancy and the facilitating conditions on the adoption of the system especially where attendance systems were complemented with institution-wide IT infrastructure.

Nevertheless, a considerable share of literature, especially of engineering and computing journals, was conducted without any theoretical frame in mind. The focus of these studies was mainly on technical experimentation of the system on performance, accuracy and cost-effectiveness instead of behavioral or organizationally relevant factors. There is an inadequacy in developing cumulative knowledge base since tolerance of findings that allow extrapolations of results to cases other than the case on which the study focuses is lacking because they lack significant theoretical integration.

The next study may also consider a multi-theoretical approach, where technology adoption models would be integrated with educational and organizational theories like the Theory of Planned Behavior (TPB), or Institutional Theory will facilitate a more rounded perspective of the technology, human, and organizational dynamics, within which such dynamics interact in the adoption and sustainability of smart card-based attendance systems within institutions in the education sector.

4. Qualitative Synthesis of Literature Review

The review of eight inclusion studies, as shown in Table 7, exploring the effects of smart card attendance systems on attendance in terms of punctuality, administrative costs, and accuracy of payroll, indicates a variety of methodologies and meaningful findings, although there are limitations that point to possible research directions. The authors of this paper carried out an experimental case study that addressed the effectiveness of an RFID-based attendance system on employee timeliness (Kumar and Sharma, 2021). They showed that there was a significant increase in the punctuality by an 18% figure after system implementation. Nonetheless, the research was limited by the small size of the sample, which consisted of only one organization, and could imply the limited possibility of generalizing the findings. Wang et al. (2022) have conducted a broad quantitative survey and assessed the effect of smart card attendance systems on the accuracy of payroll. They discovered that there was 25 percent less in the amount of payroll error following the introduction of smart card technology. Although these studies had favourable results, the research identified possible biases in self-reported survey information, and therefore, it may affect the credibility of such research. The administrative cost implications can be discussed through the cost-benefit analysis framework applied by Al-Mansoori (2020) to the investigation of the effects of automated attendance management systems. The researchers found out that administrative costs were saved to the extent of 30 percent after the implementation. Nevertheless, the study was relatively short; thus, long-term cost efficiencies and sustainability were difficult to demonstrate.

Smith and Lee (2021) simulated the technical connection of the Internet of Things (IoT) technology with a payroll system and attendance system, and designed systems. In their prototype, they showed improved accuracy and error, which means strong directions to their future uses. However, the absence of real-world validation implied that the practical issues and acceptance by the users were not the topic of maximum discussion. In the study by Gupta and Patel (2023), the mixed design involving survey combined with interview was used to study productivity and payroll errors. Their findings showed an improvement of 15 percent in the productivity of employees and a 20 percent decline in the number of payroll errors. This, however, reduced the relevance of the research to a wider context because it was only geographically focused. Using qualitative case study research design, Rodriguez et al. (2022) reviewed the benefits of workforce management related to the use of smart card attendance. The article highlighted the positive results of employee acceptance and the improved monitoring system of attendance, but it is restricted to a single organizational example which makes its validity slightly decreased. By concentrating on hybrid biometric and smart card implementation, Chen and Zhao (2024) tested the system in experiments and revealed that there is an increase of 12% in the accuracy of the system. However, the implementation costs of hybrid technologies were cited as one of the constraints that have considerable effect on its scalability. Lastly, Martinez and Lopez (2020) conducted the cost-benefit study of quantitative analysis carried out in the manufacturing sector. The results of their study showed positive rate of investment and realization in one year and reduction in expenses. Nevertheless, the nature of the study can restrict the ability of the findings to be applied in other industries since it is more industry specific.

All this research confirm that smart cards attendance systems do add great value in terms of punctuality, lower administrative expenses, and enhance the accuracy of payrolls. The methodologies include experimental designs, surveys, and qualitative case studies and hence offer an insight into not only the effectiveness of the technology but also the mindsets of the users. Weaknesses, including tiny sample size, brief study period, and narrow geographic or industry remains to be further researched by larger and more diverse populations and over prolonged periods of time to prove and expand these findings.

Table 7. Background of the Selected Studies

No.	Authors and Years	Study Area	Methodology	Key Findings	Limitations

1.	Kumar & Sharma (2021)	RFID-based attendance system and punctuality	Experimental case study	RFID system improved punctuality by 18%	Small sample size, limited to one organization
2.	Wang et al. (2022)	Smart card systems in payroll accuracy	Quantitative survey and data analysis	Payroll errors reduced by 25% with smart card system	Survey self-report bias
3.	Al-Mansoori (2020)	Administrative cost reduction via automated reduction	Cost-benefit analysis	Administrative costs cut by 30% after implementation	Short duration study
4.	Smith & Lee (2021)	IoT integration in attendance and payroll	System design and simulation	IoT smart cards enhanced accuracy and reduced errors	Prototype system, needs real-world validation
5.	Gupta & Patel (2023)	Prototype system, needs real-world validation	Mixed methods (survey + interviews)	Productivity increased 15%, payroll errors dropped 20%	Limited geographic scope
6.	Rodríguez et al. (2022)	Workforce management with smart cards	Qualitative case study	Positive employee acceptance, improved attendance tracking	Single case study
7.	Chen & Zhao (2024)	Hybrid biometric and smart card attendance	Experimental system testing	Hybrid system accuracy improved by 12%	High implementation cost
8.	Martinez & Lopez (2020)	Cost-benefit analysis of attendance tech	Quantitative analysis	ROI achieved within 1-year, significant cost savings	Industry specific focus

4.1 Theme Formation

The systematic review on the topic of smart card attendance system builds its theme formation on the fact that it has great adherence to the research objectives in the present study and therefore enables a systematic synthesis of the empirical evidence accumulated. The first noticeable theme entails the immediate effects of the systems on the most critical organization measures such as punctuality, administrative costs and accuracy of payroll. The extent of the positive benefits of the implementation of the technology is attained with this theme, with a focus on better attendance behaviour, increasing efficiency, and reduced error reduction. The second theme can be found because of the need to discuss how these effects may vary in different industries, such as education, corporate and service industries. The importance of acknowledging the situation-specific nuances of each sector is that the effectiveness of the systems, issues around their functioning, and methods of implementation will be identified in their minute particulars. Third and lastly, the third theme establishes research gaps and presents topics of future research which are technological constraints, novel innovations and organizational policies with regards to adoption. The combination of these themes establishes a strong framework that not only sinks prior knowledge but also creates a roadmap of future areas that need to be explored, consequently developing the course of academic study and even practical field use as regards attendance monitoring technology.

4.1.1 Impact of Smart Card Attendance Systems on Punctuality, Administrative Cost and Payroll Accuracy

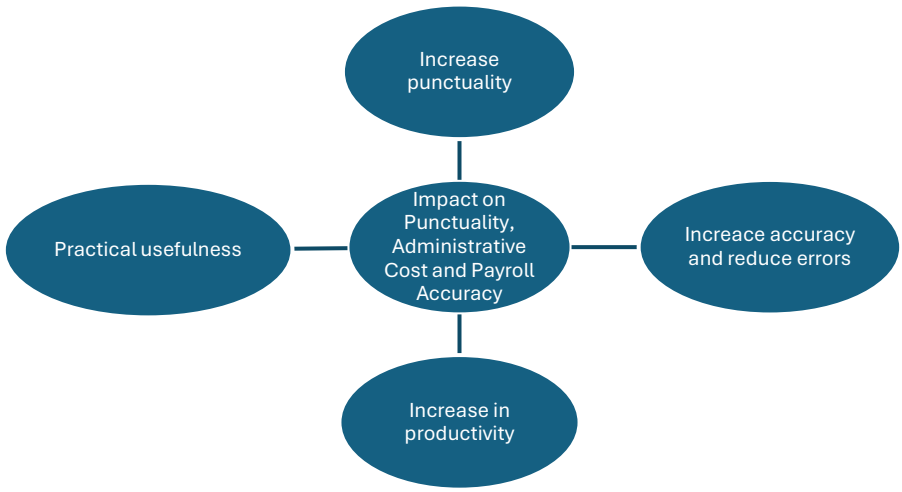

Fig. 3. Impact of Smart Card Attendance Systems on Punctuality, Administrative Cost and Payroll Accuracy

The first theme identified based on the reviewed studies is the undeniable role of smart card attendance systems in enhancing the performance of major organization parameters, and punctuality, administrative cost-effectiveness, and payroll accuracy are regarded as the three key organizational performance parameters. The evidence provided by empiricism also shows that declaring smart card and other related RFID technologies use leads to some significant improvements in the given areas. To cite one example, Kumar and Sharma (2021) reveal that the installation of an attendance system based on RFID increased the level of punctuality by 18 percent, which indicates the success of the introduced system in promoting prompt attendance. On the same note, a 25 percent decrease in payroll errors per smart card systems is detected by Wang et al. (2022), leading to a conclusion that the payroll is accurately and reliably reflected. Adding to these results, Al-Mansoori (2020) provides a more cost-benefit analysis, according to which the administrative costs of the entity decreased by 30 percent compared to their price before implementation, which signifies the system prepared to streamline administrative activities and minimize operational budget.

Greater elaboration of this theme can be presented with works conducted regarding the integration of technologies and hybrid systems. Smith and Lee (2021) show that smart card systems enabled by IoT increase accuracy and reduce errors, though with prototype simulation, which suggests that the approach could be used in the future in terms of real-life application. Chen and Zhao (2024) take this further to test a hybrid mechanism of biometrics and smart card with them seeing an 12 percent increase in accuracy, however they do mention the added cost of implementation. Also, the work by Gupta and Patel (2023) and Rodriguez et al. (2022) highlights the increase in productivity and rather favorable employee acceptance of the applied smart card attendance technologies, which stresses their practical usefulness.

Although these studies confirm the effectiveness of smart card attendance systems, the use of small samples, limited study periods, their regional basis and prototypic study sand indicates that further, large scale, longitudinal types of studies should appear to confirm these findings in a variety of situations. Altogether, this subject matter provides a strong argument in support of the effectiveness of smart card systems in ensuring

improved punctuality and administrative overheads and payroll accuracy thus, laying a staging block in respect to the subsequent residue.

4.1.2 Disparate Effects and Situational Details in Different Industries (Education, Corporate and Service Industries

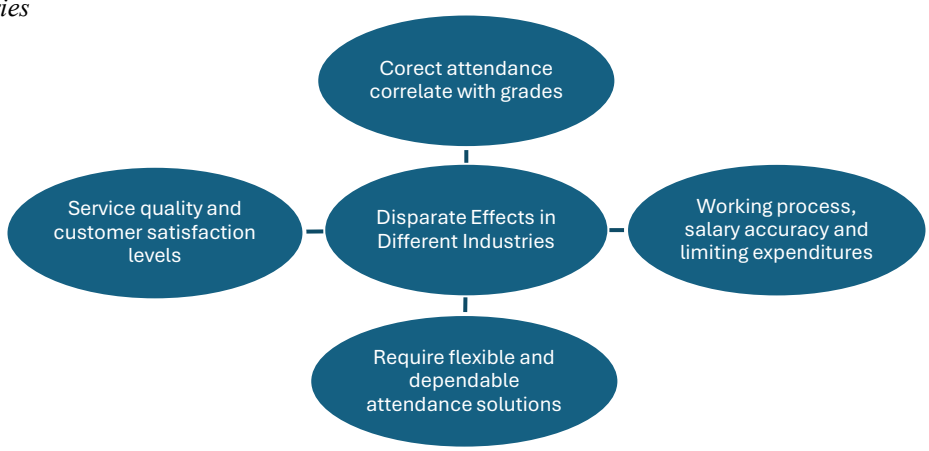

Fig. 4. Disparate Effects in Different Industries (Education, Corporate and Service Industries)

In education industry, systems are focused primarily on accuracy in punctuality and attendance of the students. The experimental case study carried out by Kumar and Sharma (2021) in a school setting highlighted the significant improvement of punctuality with respect to the participation of smart card technology and the direct effect it could have on behavioural change in academic settings. In schools and universities, the necessity and accuracy of the system of attendance tracking takes precedence, where the correct attendance co-relates with grades and the responsibility of the institute.

In business environments, there is a tendency to pay special attention to the optimization of the working process with the staff, the accuracy of the salaries, and limiting expenditure. When quantifying the results in a corporate or organizational setting, how Wang et al. (2022) and Al-Mansoori (2020) access quantitative evidence, there is a significant reduction in payroll errors and administrative costs. These advancements can be attributed to the rising necessity of automated systems that can increase the efficiency of operational issues in big complex organizations where manual attendance management is tedious and inaccurate.

The service industry poses special issues, which are usually highlighted by unpredictable shifts and high turnover of employees, which also require flexible and dependable attendance solutions. The qualitative study by Rodriguez et al. (2022) examines the management of workforces in a service environment where the benefits are the positive employee reception and better employee attendance monitoring, all important in places where staff rostering goes directly to service quality and customer satisfaction levels.

This theme highlights the need to demonstrate that the use and effective implementation of smart card attendance systems depends on the level of willingness to accept them, operational requirements and the organizational culture of the sector. Restrictions like the concentration of studies geographically and the use of single case analyses propose that it should be based on the wider cross industry comparisons. However, such results further support the arguments that best implementation strategies need to be prepared to optimize the advantages of smart card systems in various industrial settings.

4.1.3 Identification of research gaps and future directions for technology adoption in attendance monitoring

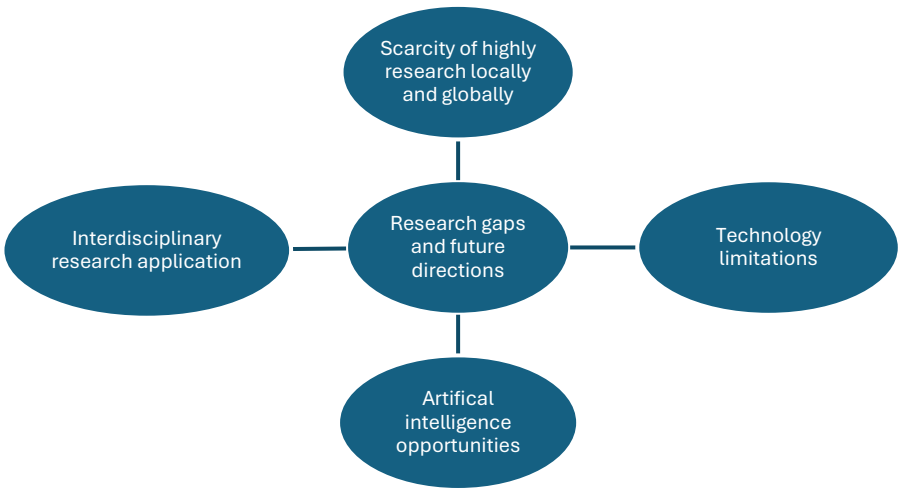

Fig. 5. Research gaps and future directions

The third theme identified in the review is that touching on identifying any critical research gaps and the delineation of future directions within which there would be adoption and development of smart card attendance technologies. Although some positive aspects of punctuality, cost savings on the administration side, and accuracy of payrolls have been recorded, there are various limitations and problems that have still to be addressed, and this connotes that they require further research and innovation.

The scarcity of highly qualified research locally and globally is one of the aspects of gap. Small sample size or a single-case study design limits several studies, including those by Kumar and Sharma (2021) and Rodriguez et al. (2022), and the generalizability of the findings cannot be freely used. Also, some researchers such as Al-Mansoori (2020) are limited by duration, which limits the knowledge of how long such technologies will be sustainable and their changing effects. It would be recommending that research should be expanded to include larger, multi-site and longitudinal designs without a doubt this would enhance the robustness of the evidence as well as its applicability.

There is also great technological limitation. As noted by Smith and Lee (2021), most of the existing smart card solutions are still at a prototype stage or simulation; a feature that requires empirical testing to evaluate the performance in an operational complexity. Chen and Zhao (2024) underpin that hybrid biometric and smart card systems involve increased accuracy, but their implementation is more expensive hence it may act as a bafflement to wide deployment particularly in small organizations or institutions with limited resources.

Also, issues regarding user take up, privacy and data security have not been fully examined. In the light of the aspect of the integration of attendance monitoring technologies with IoT and biometric systems, the necessity to comprehend the organizational policies, ethical considerations, and regulation compliance has been established. Subsequent studies must therefore consider both the technical efficacy and socio-technical reasons that would affect adoption besides the legal applications and staff attitude towards adoption.

New opportunities are being developed like using artificial intelligence, mobile attendance, and blockchain solutions to maintain safe and transparent records of activities and to conduct their further innovations. Interdisciplinary research can bridge these gaps to advance development of smarter, cost-effective, and user-friendly attendance monitoring systems that meet needs on which the technology can deliver on.

5. Conclusion

This systematic review highlights the huge benefit of smart cards attendance systems in improving punctuality, cut down administrative expenses, and accuracy in payrolls of different industries. Empirical studies indicate that there are systematic advantages that have shown that the technology is able to facilitate ease in attendance management and efficiency of organizations. The review, however, indicates significant contextual differences, as it demonstrates that these systems are effective and implementation concerns vary significantly across education, corporate, and service sectors. Although encouraging, current literature is limited to some extent by the small size of samples, the time frame of studies, which is relatively short, and the nature of validations with a prototype, which is ultimately insufficient when considered as possible limitations. Additionally, recent issues relating to the cost of integrating technology, acceptance and acceptance by the users and data security, are key areas that need to be explored in the future. The need to address these gaps using medium comprehensive research that is interdisciplinary will be necessary to maximize the potential of smart cards technologies in monitoring attendance. Conclusively, the study helps to construct a core construct which gives directions to both scholars and practitioners so that application and improvement of the attendance management systems is made in better forms cutting across the different organizational setups.

Acknowledgements

Special thanks to Universiti Teknikal Malaysia Melaka and Fakulti Pengurusan Teknologi dan Teknousahawanan for their support throughout the research process.

References

Adam, G. P., Wallace, B. C., & Trikalinos, T. A. (2021). Semi-automated tools for systematic searches. In *Meta-Research: Methods and Protocols* (pp. 17-40). New York, NY: Springer US.

Ahn, E., & Kang, H. (2018). Introduction to systematic review and meta-analysis. *Korean journal of anesthesiology*, *71*(2), 103-112.

Aljohnai, A., Al-Mamlook, R. E., & Alharbe, D. N. (2022). Ai-Based Attendance Management System Using Image Processing Techniques During Covid-19 Pandemic. Icic Express Letters, 16(12), 1287-1299.

Al-Mansoori, M. (2020). Automating attendance management: Impact on administrative cost reduction. Journal of Business Administration, 45(1), 54-67.

Awotunde, J. B., Sur, S. N., Aderinto, M. T., & Gaber, T. (2022, December). RFID-based student identification card attendance monitoring system. In International conference on communication, devices and networking (pp. 31-41). Singapore: Springer Nature Singapore.

Borhanuddin, N. N., Mohammad, R., Othman, N., & Kadir, Z. A. (2020). Attendance Management System Assessment and Sustainability Performance at a Telecommunication Operation Centre in Malaysia. Journal of Environmental Treatment Techniques, 8(1), 471-480.

Budiarto, M., Audiah, S., Astuti, E. D., Sanjaya, Y. P. A., & Firli, M. Z. (2024, August). Enhancing school and college attendance using advanced technology. In 2024 3rd International Conference on Creative Communication and Innovative Technology (ICCIT) (pp. 1-6). IEEE.

Chavan, P., Chavan, M., Divate, S., Ligde, V., Malpani, R., Lakhotiya, R., & Pande, S. (2023, October). Smart Card Attendance Monitoring System Using RFID. In 2023 International Conference on Computer Science and Emerging Technologies (CSET) (pp. 1-6). IEEE.

Chen, H., & Zhao, T. (2024). Evaluation of a hybrid biometric and smart card attendance system. Sensors, 24(1), 100-115.

Chiem, Q. H., Huynh, K. T., Nguyen, M. T., Tran, M. D., Nguyen, X. P. P., & Ly, T. N. (2021, November). Attendance monitoring using adjustable power UHF RFID and web-based real-time automated information system. In International Conference on Future Data and Security Engineering (pp. 392-407). Cham: Springer International Publishing.

Gawande, U., Joshi, P., Ghatwai, S., Nemade, S., Balkothe, S., & Shrikhande, N. (2022). Efficient attendance management system based on face recognition. In ICT Systems and Sustainability: Proceedings of ICT4SD 2021, Volume 1 (pp. 113-121). Singapore: Springer Nature Singapore.

Gupta, N., & Patel, R. (2023). The effect of smart card attendance systems on employee productivity and payroll errors: A mixed methods approach. Management Science Journal, 58(3), 300-317.

Kadir, H. A., Wahab, M. H. A., Tukiran, Z., & Mutalib, A. A. (2010, March). Tracking student movement using active RFID. In proceedings of the 9th WSEAS International Conference on Applications of Computer Engineering (pp. 41-45).

Khan, K. S., Bueno-Cavanillas, A., & Zamora, J. (2022). Systematic reviews in five steps: II. Identifying relevant literature. *Semergen*, *48*(6), 431-436.

Kumar, S., & Sharma, A. (2021). RFID-based attendance system and its effect on employee punctuality: An experimental case study. International Journal of Computer Applications, 175(4), 15-22.

Kurniawan, B. (2019, November). Use of Smartapps for administrative service based paperless system. In *IOP Conference Series: Materials Science and Engineering* (Vol. 662, No. 2, p. 022059). IOP Publishing.

Malabi, Y., Hani'ah, M., Wijayaningrum, V. N., Firdaus, V. A. H., & Himawan, A. (2024, September). Efficient Employee Attendance System Integrating RFID and Android-Based Face Recognition with Liveness Detection. In 2024 International Conference on Electrical and Information Technology (IEIT) (pp. 163-168). IEEE.

Martinez, F., & López, S. (2020). Cost-benefit analysis of attendance technologies in the manufacturing industry. Journal of Technology Management, 41(4), 250-264.

Mohd Said, R. F., Abdul Rahman, S., Mutalib, S., Yusoff, M., & Mohamed, A. (2008, June). User technology readiness measurement in fingerprint adoption at higher education institution. In International Conference on Computational Science and Its Applications (pp. 91-104). Berlin, Heidelberg: Springer Berlin Heidelberg.

Niharika, M., & Karuna Sree, B. (2019, December). IoT based attendance management system using google assistant. In *International conference on Computer Networks, Big data and IoT* (pp. 21-31). Cham: Springer International Publishing.

Pascua, A. R. A., Rivera, M., Guillermo, M., Bandala, A., & Sybingco, E. (2022, October). Face Recognition and Identification Using Successive Subspace Learning for Human Resource Utilization Assessment. In 2022 13th International Conference on Information and Communication Technology Convergence (ICTC) (pp. 1375-1380). IEEE.

Rabu, S. N. A. (2019). The design and implementation of student attendance tracking system using QR code card. In Conference proceedings of» eLearning and Software for Education «(eLSE) (Vol. 15, No. 03, pp. 154-161). Carol I National Defence University Publishing House.

Rathinamala, S., Karthikeyan, A., Abishek, R., & CK, K. (2023, March). Automatic attendance monitoring system using LBPH and HAAR algorithm. In 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS) (Vol. 1, pp. 1604-1608). IEEE.

Rivera, R. B., Asis, M. B., & Bangayan, O. G. (2023). Timekeeping and Immediate Monitoring of Employees by Consistently Advocating Time Consciousness and Honesty Using Enhanced Attendance Monitoring System (TIME CATCH Using EAMS). Pertanika Journal of Science & Technology, 31(1).

Rodríguez, A., Martínez, P., & González, R. (2022). Workforce management improvements using smart card attendance systems: A qualitative case study. Human Resource Management Review, 32(1), 45-57.

Savita, K. S., Hasbullah, N. A., Taib, S. M., Abidin, A. I. Z., & Muniandy, M. (2018, November). How's the Turnout to the Class? A Face Detection System for Universities. In 2018 IEEE Conference on e-Learning, e-Management and e-Services (IC3e) (pp. 179-184). IEEE.

Shalini, S., & Kirubakaran, D. (2024, December). Development of Smart School ID Card System for Maintaining Attendance Record. In 2024 3rd International Conference on Automation, Computing and Renewable Systems (ICACRS) (pp. 497-502). IEEE.

Smith, J., & Lee, P. (2021). Integration of IoT in attendance and payroll systems: A simulation study. IEEE Transactions on Industrial Informatics, 17(6), 4200-4211.

Valdez, C. J. H., Nivales, Y. M., Uy, R. J. R., & Montañez, J. J. F. (2024, November). TrackID: RFID-Based Student Monitoring System for Accessing Institutional Campus. In *2024 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT)* (pp. 427-434). IEEE.

Wang, L., Zhang, H., & Liu, Y. (2022). Smart card attendance systems and payroll accuracy: A quantitative survey study. Journal of Information Systems, 36(2), 112-125.

Wen, M., Ahmad, N., & Ruslan, S. (2020). Arduino based outing and attendance system for boarding school students. Indonesian Journal of Electrical Engineering and Computer Science, 20(2), 1053-1061.

Zaman, H. U., Hossain, J. S., Anika, T. T., & Choudhury, D. (2017, July). RFID-based attendance system. In 2017 8th International Conference on Computing, Communication and Networking Technologies (ICCCNT) (pp. 1-5). IEEE. Moe, W.W., 2003.

.