Article

Examining an Information System (IS) Solution to Increase UK University Students' Engagement during Lecturing Activities

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Abstract: "Knowledge transfer" is achieved through sharing or disseminating knowledge, and providing inputs to problem solving; it is commonly associated with attending a series of classroom lectures and maintaining students' engagement with the taught subject. This paper examines how a specific radio frequency identification (RFID) based information system (IS) solution could be utilized to help monitor and increase engagement of university students during lecturing activities. This IS solution relies on student attendance as the main method to measure their engagement. Initially, the main stakeholders were identified: students, lecturers, administration team and the Student Loans Company (source of funding). A value proposition canvas was subsequently created, and potential system requirements were identified. A design of the proposed RFID based system was created based on these requirements and then compared with a real-life (already existing) system at Henley Business School. By comparing these two systems, the authors determined related benefits/drawbacks of the proposed system in monitoring student engagement. Potential benefits consisted of allowing all parties to easily capture attendance (with very minimal involvement of the university's staff) and increased efficiency in analyzing student attendance data. Its main limitation was inaccurately capturing the exact time a student leaves a session. Building a working prototype for detailed evaluation and further fine-tuning/improvements must be part of future work.

Keywords: classroom educational activities; knowledge transfer; student attendance; student engagement; radio frequency identification (RFID); based information system

1. Introduction

The purpose of this research effort was to design an information system (IS) solution that could help to increase engagement of the United Kingdom's (UK) university students during their studies (and briefly identify related pros and cons). That effort was conducted at the leading author's mother institution (Henley Business School (HBS), UK). To begin designing a system with the capacity of monitoring engagement, it was essential to find a way to effectively measure the targeted outcome (students' engagement). Traditionally, attendance was utilized as the primary method of measuring students' engagement, with a plethora of prior academic studies during the previous decades, both from and outside the UK, clearly showing that attendance was (and still remains) closely correlated with (student) engagement and performance. These researches correctly identified that there is a positive correlation between student attendance and student engagement. When the attendance of a class is low, engagement also tends to be negatively impacted. A few indicative examples of case studies (with a rather old timeframe) examining student engagement that support this concept were those of Caldas (1993), Romer (1993) and Newman-Ford et al. (2008) [1–3].

However, there is now a need to factor in the COVID-19 pandemic, which heavily influenced "ordinary lecturing activities" [4,5]. A new paradigm of online delivery of

lectures was obligatorily created, and with the shift caused by COVID-19, it is often argued that lecture attendance does not have a direct effect on academic outcomes, but it can still promote performance by leveraging online learning engagement and formative assessment performance. For example, in a survey conducted in an Indian university shortly after the breakout of the pandemic, 358 undergraduate students were asked about their opinion on different aspects of online education: the students felt that they learn better in physical classrooms (65.9%) than through online education [6]. The same notion is supported by the findings of studies such as Lu et al. (2022), which examined the impact of in-class attendance on course academic performance and the interplay of in-class and online-learning engagement factors in the context of technology-enhanced courses [7]. But, governments around the world still put a lot of emphasis on attendance to increase engagement. For example, in the UK's Student Attendance and Engagement Policy, there is a heavy focus on attendance with the aim to improve engagement [8]. On a similar notion, in New Zealand's counterpart policy, attendance is still considered as one of the key factors to capture the related level of engagement [9]. In any case, it is not a coincidence that the University of Reading (UoR), which HBS is part of, collects student attendance and engagement data to monitor student success [10]. This serves as a very strong motivation for using attendance as the method to measure engagement in this research effort.

As such, the IS solution to be recommended was made by utilizing student attendance as the basic operating principle; students' attendance was then used as the basis to evaluate their overall engagement with the taught subject. Research on UK universities and their students showcased various indicators that could suggest student attendance could be decreasing for face-to-face lectures. There are students who have already voiced their preference exclusively for online lectures, which could encourage them to not attend physical classes. There are even a number of academic studies that suggest that attendance has been decreasing when lectures are delivered in the classical "face to face" mode. Further research also puts to question the validity of existing systems that capture student attendance. These systems are prone to certain disadvantages, such as students being able to fake their attendance. Subsequently, potential stakeholders for an IS solution that monitors student engagement were analyzed. A value proposition was created, taking into consideration "what the students want" as customers and what kind of products and services the university offers, as well as factors that might impair or enhance these. The value proposition showed that an attendance monitoring software program would be beneficial to both students and universities. With all of this information in mind, a list of potential requirements for the IS solution was developed. These requirements were used as the basis for determining what the high-level technical design of the IS solution could potentially look like. A process chart example demonstrating the flow of the IS solution, as well as the relationship between different system components and stakeholders, was also created. In order to assess how the system could be improved, a variety of ethical and legal concerns were taken into consideration. In addition, this system was compared against an example of an existing system, from HBS, to evaluate the benefits of the new system, including its potential limitations. It is crucial to highlight that this research effort examines the theory supporting the design of a new IS solution; therefore, it clearly focuses on theory and lacks benchmarking against a real-life working prototype to fully assess areas for improvement. As such, this prototype, which is essential for testing and further improvement purposes, must be built as soon as possible and will be the first step of future work.

2. Materials and Methods

2.1. Problem Background

Before proposing a suitable IS solution to monitor student engagement, introducing a method to effectively measure this (student engagement) is crucial. This section discusses the correlation between attendance and engagement. In both the UK and abroad, a number of academic studies have been performed that support the concept of student engagement

being closely correlated to attendance. These studies have been performed in relation to both primary and secondary students, as well as those in higher education. In 1993, Caldas conducted research on student attendance and performance across Louisiana public schools (in the United States of America, US). His research led to the conclusion that these were in fact connected and that Louisiana schools would "be richly awarded" with student engagement by maximizing student attendance [1]. Around the same time, Romer also conducted similar research, but namely on higher education students, from an assortment of US universities and colleges. Based on his findings, he concluded that student attendance "may substantially affect learning" [2]. In 2008, while conducting research related to student attendance and performance in four different undergraduate UK programs, Newman-Ford et al. also came to a similar position, namely that there was a strong correlation between students' attendance and the successful completion of their studies or assessments [3]. These are but a few examples of the academic literature that could be used to support the notion of attendance being a valid method to measure the engagement of undergraduate and postgraduate university students. More recently, a study by Webber (2020) identified student attendance as a crucial prerequisite to student engagement and wellbeing, highlighting a linear correlation between attendance and attainment [11]. In a similar direction, even after the COVID-19 era, the results of Kitada et al. (2021) indicated that "*online learning was perceived to be a good alternative under COVID-19 while face-to-face learning was preferred by most students due to the various merits of the learning environment, such as interactions and engagement*" [4].

One must not forget the correlation between attendance and academic success. If an engaged student is believed to perform well, then students that attend their classes regularly should also perform well. This is supported by formal government policies such as those of the UK and New Zealand [8,9]. There is also a variety of academic literature that supports the notion that "students who attend regularly, tend to perform well". An example is the case study of Kim (2020), which notes that while there are mixed findings to the correlation between attendance and performance, attendance can still have an indirect effect on the performance of students [12]. It is crucial to not forget that while a student may attend class, they might not really be engaging with the course material, which would lead them to underperforming. Again, there is plenty of academic literature that highlights how crucial it is to understand whether students are really engaged (or not) during the effort to find out why they are performing well or not. An example is Buchele's case study (2020), which comes to the conclusion that attendance might not have a significant effect on students' success, as long as they remain motivated and engaged with the course [13]. Evaluating students' engagement by monitoring their attendance could also be beneficial to both the students and their host universities. For example, a student could potentially use details about their overall attendance as a self-assessment tool to track their own progress. Access to such a tool could potentially encourage students to attend even more lectures and set their own personal targets. These targets could consist of avoiding attending lectures late or attending more lectures than usual. Attendance can also be used by the university to assess how engaged students are with each of their modules. If a student is missing multiple lectures, then this could be used as an indicator that they are not very engaged with their studies. Knowing this would then allow the university and lecturers to take appropriate actions. For example, they could make changes to their teaching methods to help encourage students to be more engaged, or identify students who actively miss lectures, discuss/resolve the situation with them, and when necessary, take disciplinary actions against them. As tracking attendance is a valid method to measure engagement, and at the same time can also bring an assortment of benefits to both universities and students, a potential IS solution should be developed with tracking student attendance in mind. Based on the information acquired from tracking student attendance, appropriate actions could be taken by the universities and the students themselves to improve student engagement and the associated knowledge transfer.

There are certain indicators that could be used both in support for and against the idea that student engagement in the UK has been decreasing. An example supporting that student engagement is decreasing is through the Student Academic Experience Survey 2021. In this survey, over 10,000 UK undergraduate students were approached to be questioned about experiences with their courses [14]. Of these students, 12% stated they would prefer to have online classes exclusively, and a further 31% preferred a combination of both online and physical classes [14]. This is a significant proportion of students from this sample that have a preference for a hybrid or online-only classes. Such a high proportion of students suggests that there are students who might be incentivized to not (physically) attend classes. The material is delivered in person, which is contrary to their preference. And the phenomenon of students encouraged to miss lectures was evident even before the Coronavirus pandemic. A survey in 2020 from the Higher Education Policy Institute (HEPI) showcased that class attendance was already declining, with an estimated 0.5% decrease in student attendance rates between the periods 2016–2017 and 2018–2019 [15]. The phenomenon of declining attendance can be captured outside of the UK, too. For example, the Times Higher Education launched a survey that came to the conclusion that attendance, and consequently the engagement of students, has been plummeting around the world [16]. While the focus of this paper is on the undergraduate and postgraduate setting, it is also worth mentioning that a similar phenomenon of a decline in student attendance has been observed post-COVID in regular schools across England [17]. As student attendance is decreasing, it naturally brings to question whether student engagement is also decreasing, because of their correlation that has already been established. On the other hand, there are still a few studies that reject the idea of student engagement plummeting. For example, the UK Engagement Survey showed that attendance "largely bounced back to pre-pandemic levels" [18]. It could be argued that academic studies are conflicted on this issue.

Another reason highlighting the necessity to further explore how monitoring student engagement could be improved is the increasing pressure by the UK government on universities regarding the attendance of their students. Examples of that are the actions of the former Minister of State for Higher and Further Education. When Michelle Donelan was in office in 2022, she warned top education chiefs that universities should return to in-person teaching [19]. If student attendance did not reach the "pre-pandemic levels of face-to-face teaching", then universities could face fines or lose access to funds from the student loan system [19]. This is crucial because many university students are reliant on loans from the UK government to conduct their studies. As of 2022, on average, GPB 20 billion is loaned to around 1.5 million students in England every year, with the value of outstanding loans by the end of March 2022 reaching GPB 182 billion [20]. The consequences of losing access to such funds would be detrimental to both universities and students. Students would be at risk of losing a financial source that could aid them in paying for their studies, while universities would lose potential customers (since students would not be able anymore to pay for university services).

It is necessary to note that the most common method of capturing student attendance in the UK is through electronic attendance systems. This type of attendance tracking is usually performed by having students complete an online form to sign in to their physical or online lectures. There are a variety of institutions that use online forms to track student attendance. For example, Warwick Business School (WBS) captures lecture attendance through online forms (WBS, 2023) [21]. HBS uses a combination of online forms and paper attendance forms but relies more on the former to track students [22]. The University of Cambridge also captures student attendance through online forms (UOC, 2023) [23]. In a similar direction, Manchester University recently introduced a new monitoring system, which heavily relies on using online forms for students to sign in [24]. There are various potential advantages and disadvantages to using online forms to track student attendance. A few of the most prominent ones are listed in Table 1, below:

Table 1. Advantages and Disadvantages of an Online Attendance Form (created by the authors).

Advantages	Disadvantages
Students can capture their attendance quickly and efficiently. They only need to complete a short online form.	Reliability of data is questionable. Students could fake attendance when provided access to the online form by classmates.
Involvement of staff to help capture student attendance is minimal. Students can complete the form on their own. The lecturer only needs to provide a QR code or an embedded link.	Involvement of staff to help analyze collected data may be substantial. A dedicated team may be required to review data when this process is conducted manually (as opposed to using monitoring software).
A versatile way to capture attendance. Attendance can be shared through a QR code or an embedded link anywhere.	Internet connection required. Cannot access the online form otherwise.
Can easily store a lot of student data. Beneficial for modules that contain a lot of students.	Does not reliably capture when a student arrives or exits from the class. A student cannot be trusted to always enter accurate details about when they come to lectures.

2.2. Stakeholder Analysis

There is a wide range of stakeholders for the development of an IS solution that would monitor student engagement by tracking their attendance. Internal stakeholders would consist of students and lecturers. Lecturers bear much responsibility for providing lectures and learning material as part of the university's services. As a student may have several module governors and lecturers, due to attending different modules, all of these staff members will be included under the umbrella of lecturers and module governors, as they would likely still serve the same function within the IS solution. Students are the customers of the service, so they count as another crucial stakeholder. Internal stakeholders could also consist of the staff members who are tasked with monitoring attendance records and producing relevant reports. As these staff members fulfill a similar function, they will be included under the umbrella of an administration team. This is to simplify explaining their role within the system. It is crucial to note, though, that not every university has such a dedicated team. Another important external stakeholder to pay attention to is the Student Loans Company. This is a branch of the UK government that provides loans to UK students. Its inclusion was necessary because of the increasing government pressure previously mentioned. It is crucial to note that as students may also be international, they may not have access to loans from the SLC. In such a case, they may acquire loans from other, similar kinds of services. For example, Swedish students can acquire loans or grants from the equivalent branch of the Swedish government, CSN [25]. Even though the IS solution will consider SLC as one of the actors involved in this system, other, similar services such as CSN can fulfill the same function as SLC. In any case, in Table 2 below, the influence and interest of the related stakeholders (both internal and external) are summarized. Students, lecturers and the administration team supervising the attendance monitoring system are internal stakeholders. Because of their extensive involvement in the classroom setting and their roles in monitoring attendance, they would all be of high interest and influence in relation to the design of a new monitoring system.

Table 2. Influence and Interest of Internal/External Stakeholders (created by the authors).

Students Role: These are the customers of the service. The IS solution monitors their engagement by tracking their attendance.	Influence: High Without the students, the process of capturing attendance cannot begin. For example, a system utilizing an RFID scanner would require the student to scan their ID card to capture their attendance. This action of capturing attendance would generate the "student attendance data" that would serve as an input for the system. In addition, the student's own personal data, the "student data", would be required as an additional input for the system to function. These data could consist of personal details such as the student's name and modules they are attending. The student would also play a role at the end of this entire process: The system would output statistics and other details related to their attendance, which would then be visible to them through their university's choice of a user interface.
	Interest: High Students are concerned with achieving high grades and completing their courses successfully. An IS solution that helps monitor their own progress would be seen as beneficial by them. As they are users of the system, they would likely want a design that makes capturing their attendance as easy as possible for them. In addition, they would want to easily access records and statistics about their attendance. The student would likely also want to receive some form of confirmation that their attendance has been captured, to avoid any unnecessary confusion. If a student cannot prove later that they attended a class and that the system simply did not capture them, then they may face trouble for no reason, leading to frustrated customers.
Lecturers and Module Governors Role: They bear responsibility for the teaching and learning of students. They may be required to help with taking attendance depending on the system.	Influence: High The lecturers might be required to generate "student attendance data" by assisting students with recording their attendance. For example, a system that utilizes a QR code linked to an online attendance form would require the lecturer to show to the class this exact code. The lecturer would also play a role at the end of this entire process. They would see their students' attendance records and other relevant attendance statistics through their university's choice of a user interface.
	Interest: High The lecturer would like to know accurately how their students are engaged with their courses by accessing their attendance records and other relevant statistics through their university's choice of a user interface. Monitoring student attendance can be used as a method to evaluate this engagement. As a consequence, the lecturer would like to see a system that would capture this attendance accurately. Knowing as many details, such as the exact time the student arrived at a lecture, would be very beneficial. In addition, as the lecturer may assist in capturing the attendance of students, they would likely want to see a system that removes as much pressure from them as possible. This would consist of minimizing their involvement as much as possible and, when applicable, making the system as easy as possible for the lecturers to use. Keeping this in mind, the system would need to be easy for the lecturer to use. Ideally, it would also require that it minimize as much of the lecturer's involvement as possible so that they can focus on teaching their students.
Administration Team Role: Responsible for monitoring student attendance.	Influence: High The administration team may be responsible for supervising and maintaining various components of the system, depending on the IS solution that is applied. As a demonstration of this, a system using Google Spreadsheets to store "student data" or "student attendance data" would require that the administration team manually process those records and conduct analysis to identify students who have not attended lectures. The administration team may also have the responsibility of providing updates or reports for the lecturer or module governor. For example, Henley Business School teaching staff "liaise with their Program Administration team regarding attendance data capture" [22]. As such, the administration team has the potential to significantly affect the system.
	Interest: High The administration team is responsible for supervising and maintaining various components. It might also need to produce reports to notify the relevant lecturers/module governors of students' attendance or absence. As such, the administration team would be greatly concerned with the design of the IS solution. Making the system as efficient as possible would be a priority for this stakeholder. It would also need to adhere to the university's ethical guidelines and to legal frameworks such as data protection laws. Alleviating as much pressure as possible, through automation for example, would be a great benefit to the administration team, too.

Table 2. *Cont.*

Student Loans Company (SLC) Role: A "non-profit government-owned organization" providing student loans to UK students [26]. It operates under the UK Department of Education.	Influence: Low The SLC cannot dictate how each university should monitor their students' attendance. Furthermore, the role of the SLC within the system is very limited. At the end of the entire process, the student may acquire a separate stamped form from their university that serves as evidence of their attendance throughout their course.
	Interest: Medium Currently, the SLC is only concerned with students providing some form of documentation that can be used as evidence to prove that they have attended their courses (GOV.UK, 2023) [27]. Students will only be penalized if they fail to deliver this information or, upon proof, provided inaccurate or false information (GOV.UK, 2023) [27]. However, given the increasing pressure of the UK government on universities regarding student attendance, there is a high possibility that the SLC will become stricter in what they require in the future.

2.3. Value Proposition Canvas

A summary of the value proposition (also including relevant "gains" and "pains") for the IS solution under discussion is provided with the help of the value proposition canvas below (see Figure 1). Students are considered the customers of the service; they want to engage with lectures in order to achieve the necessary knowledge transfer, achieve high scores in their coursework, and successfully complete their studies. To achieve these, universities offer networking opportunities, high-quality education and efficient student services to assist students. Increased participation is a gain for the student. It is one of the positive outcomes that they desire. The student wants to participate in more lectures and seminars in order to develop a better understanding of the course they are studying. Receiving some recognition for their participation would be a gain creator. This is because their attendance is an indicator of their performance, so they would feel they are engaging in their academic life. Improved personal performance is also a gain. This is because the student wants to achieve better grades and academic performance. Receiving personalized feedback can help enhance this. It is a gain creator because, by receiving personalized feedback on their progress and how to maintain it, the student would feel more confident about achieving their academic goals. Tracking their own accomplishments is another gain. The customer wants to track their own progress and accomplishments in order to better understand their strengths or weaknesses and to set future personal goals. Self-assessment tools can be used to achieve this. These tools are a gain creator because, by using them, the student may gain a better understanding of their exact strengths and weaknesses, which can then help them set up their personal goals more effectively.

On a different note, the lack of motivation is a pain. It represents a negative outcome that the student would want to avoid. In this case, the student may experience a lack of motivation to attend in class or to study, which could potentially lead to a poorer academic performance. If the student has more engaging and entertaining lectures and seminars, they would be more incentivized to participate. As they are more motivated to attend these activities, they might achieve better academic performance (thus, making this a pain reliever). The difficulty of tracking their own progress is another pain. This is because when the student finds tracking their own progress challenging, they may have problems with setting personal goals, which could lead to poorer academic performance. Hence, this is another outcome for the student to avoid. Personalized feedback can be used in addressing this issue, making it a pain reliever. This is because the students would then have a better understanding on how to set their own personal goals and track their own progress. Avoiding participating in lectures and seminars is another pain. That would obviously lead to poorer academic performance and the student being more disconnected from academic life. Advice on how to not only increase their participation in class but also encourage their involvement in other events such as placement fairs or networking events would be a pain reliever. This is because the student would feel more comfortable to attend both their classes and events and would build up their own network of connections

that could potentially lead to better academic performance. An attendance monitoring system could be used to assist in achieving these pain relievers or gain creators. For example, it could be used to assist in tracking their attendance in lectures, seminars or other extracurricular events like networking opportunities. Based on this information, areas for improvement could be identified, and then students could receive personalized feedback and advice on how they could improve their participation in academic life. An attendance monitoring system could also be used by students as a self-assessment tool to track their own progress. Thus, the "value proposition" for universities is to produce an effective monitoring system that allows both students and the university to engage in achieving these pain relievers and gain creators.
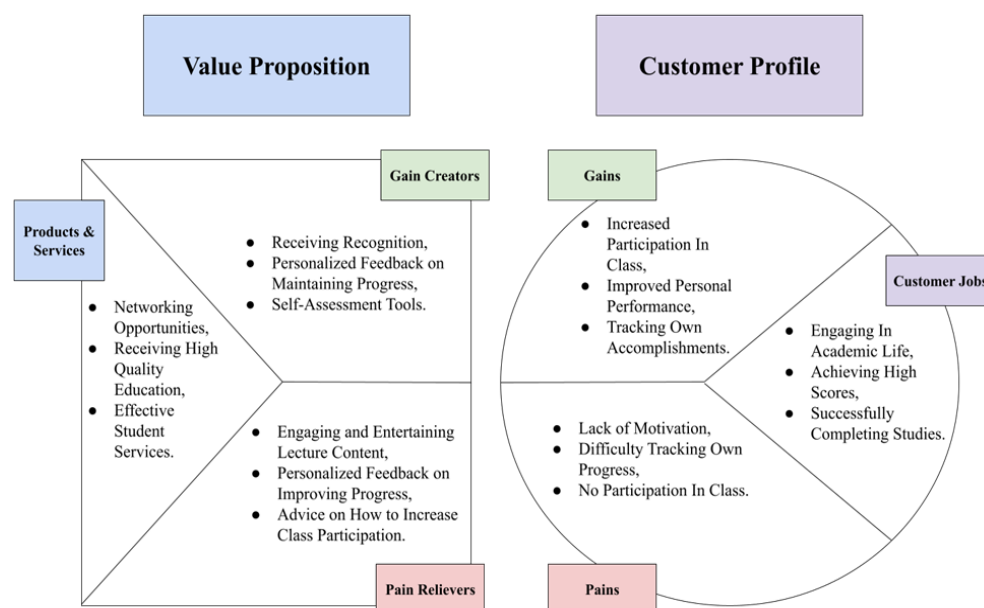

Figure 1. Value Proposition Canvas (created by the authors).

2.4. Requirements Analysis

To enable the system to properly function, student attendance data and (student) personal data are required. These data details may consist of information such as modules students attend and dates and times of allocated sessions for these modules, as well as certain personal details (e.g., student identification number (ID), student name/surname). The assumption is only that this information regarding the student is necessary from the university to monitor attendance. Another assumption is that all student data will be stored within a centralized student database. On the other hand, student attendance data consist of information such as the student's ID and the date and time that they arrive at a lecture or seminar. To generate the attendance data, students need to scan their ID cards on a RFID scanner. With this approach, involvement of the lecturer in capturing attendance data is minimal. Their responsibility is only in assisting in manually processing the attendance of a student who has lost their student ID card. This was previously mentioned within the stakeholder analysis (see Section 2.3). The ID scanned will then be matched against the ID retrieved from the student database to determine whether the student attended the session. The part of the system performing this action is a data processing platform. The assumption is that this platform will only consist of a student attendance database, where retrieved and processed information is stored, a monitoring software program performing functions such as retrieving and matching IDs, analyzing attendance and producing output such as attendance statistics for a student on a personalized report, and a server where both the system software and attendance database components operate from. The monitoring software would be developed by the university's own IT department. Both students and lecturers need visual representation of the output of the system, which could come from a

user interface such as a university application or a website. The output would be pushed by the data processing platform to the user interface. The student data and attendance data that the data processing platform requires to process to create an output are both sensitive. Hence, the system would also need to be as secure as possible to protect students. Finally, the system would also need to be sustainable to be employed by a university. Indicators that suggest a system would be sustainable would be being efficient and accurate while capturing student attendance while also being cost-effective. Hence, these should also be considered when developing a system. Based on all of these factors, the following functional and non-functional requirements can be derived (see Table 3).

2.5. Technical Design

Figure 2 below summarizes a potential logical system architecture design for the proposed system. When students arrive at a lecture, they will scan their ID card. The RFID scanner will produce, through this action, the "student attendance data", one of the inputs of the system. It will capture information such as the exact date or time students scan their ID card. Through the student database, personal details regarding the student (e.g., student name, student age) and information related to their university course are extracted (e.g., modules the student attends and which lectures to attend). These make up the "student data", another one of the system's inputs. These inputs are processed through a "data processing platform", which is composed of key system components of the student attendance database, the monitoring software and the server. These operate as a cohesive unit. The monitoring software is connected to the RFID scanner and the student database, and it will collect student attendance data and student data. The monitoring software will be produced by the university's IT department to support the system. In the student attendance database, the student attendance data and student data that have been collected will be stored, retrieved from and processed. The student attendance database and the monitoring software will be installed on the same server. Hence, the server would also be responsible for managing the student attendance database, processing requests from the monitoring software, and storing the appropriate data in the student attendance database. The data processing platform will be under the supervision of the administration team, though the process of extracting and analyzing the inputs and producing an output will be performed automatically by the system. Once the data processing platform processes student data and student attendance data, an attendance report for each student will be produced. This report will be pushed by the server to the university app or website. These will function as the user interface where students, lecturers or the administration team will access reports of their interest. The most relevant "Key System Functions" are detailed in Table 4.

Table 3. Functional and Non-Functional Requirements of the Proposed System (created by the authors).

Functional Requirements	Non-Functional Requirements
	For the entire system: • Be efficient and easy to use. • Be cost-effective. • Be operational at all times. • Comply with ethical guidelines and data protection laws. • Manipulate student attendance data. • Manipulate student data. • Produce accurate results. • Provide secure user access. • Provide in-depth information.
For the student: • Scan their ID card. • Access information related to their attendance through a user interface.	
	The monitoring software to: • Have access to student attendance data (through RFID scanner), and student data (through the student database).

Table 3. *Cont.*

Functional Requirements	Non-Functional Requirements
For the lecturer: • Be capable of manually processing the student's attendance. • Access details related to each of their students' attendance through a user interface. • Access information related to overall class attendance.	For the database: • Store student attendance data. • Store student data.
	For the RFID scanner: • Record time and date of attendance. • Have access to the student data (through the student database). • Be connected with the monitoring software.

Table 4. Key System Functions of the Proposed System (created by the authors).

Key System Requirements	Justification
Scan student ID cards.	This is one of the system requirements. This action produces the attendance data, which are one of the necessary inputs for the system to function.
Analyze student data and student attendance data.	Another system requirement is for users to be provided with information related to student attendance. In order for the system to produce such an output, analyzing both attendance data and student data is necessary.
Generate an attendance report.	Based on requirements, users need information related to student attendance. An attendance report can be an easy visual representation of this, providing in-depth information related to each student's attendance.

System Components: Hardware	Description	Function
RFID Scanner	The hardware used to scan the students' ID cards. Necessary to produce attendance data.	Scan student ID cards.

System Components: Software	Description	Function
Monitoring Software	Developed by the university's IT department. Connected to the RFID scanner and student database. Will process and analyze these data and store them within the attendance database.	Extract data from the RFID scanner. Extract data from the student database. Analyze student data. Analyze attendance data. Send data to the attendance database.
Student Attendance Database	To store attendance data and student data. It will be accessible from the monitoring software, which will analyze these data and store the output within the attendance database.	Store attendance data. Store student data. Store output data.

Table 4. *Cont.*

Key System Requirements		Justification
University App/Website	This is where users can access the generated attendance report.	Provide user access to attendance reports.
Student Database	Information personal to students (e.g., student name) or related to courses (e.g., modules student attends) is stored here.	Provide access to student data.
System Server	The monitoring software and the attendance database are stored within this server. In addition to assisting with their functions, the server generates the attendance report that is sent to the university app/website.	Generate the attendance report. Send the attendance report to the university app or website.
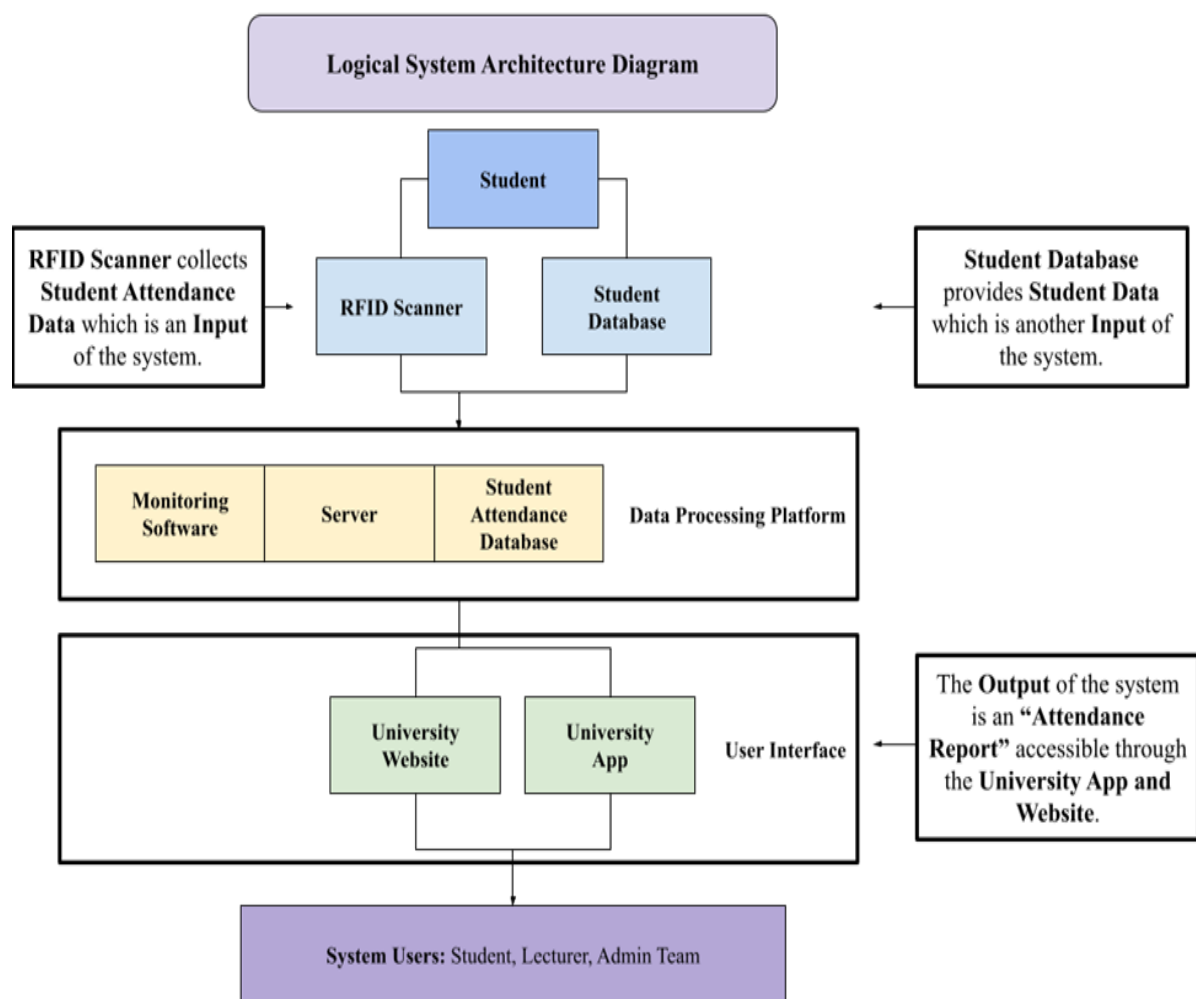
Figure 2. Logical System Architecture Design (created by the authors).

3. Results and Discussion

3.1. Example Processes

The two different process diagrams in Figures 3 and 4 (below) demonstrate, and are used in order to compare, the process for an existing attendance monitoring system (from HBS, University of Reading) and that of the proposed IS solution, respectively. More details about the comparison of the role of each stakeholder in the existing and the proposed system are also provided below:
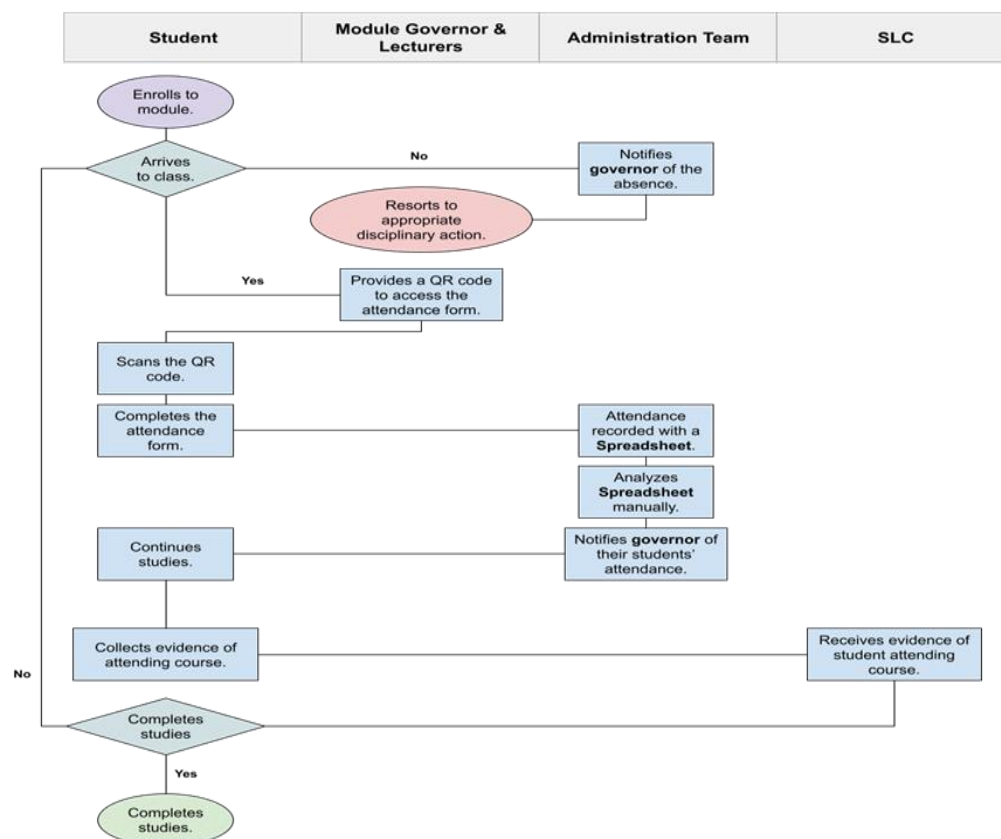
Figure 3. Example Process of an Existing Attendance Monitoring System (University of Reading).

Students and Student Loans Company: In both systems, the process begins with the student enrolling and subsequently attending their lectures and seminars. In comparison to the existing system, where students need to complete an online form accessible through a QR code, the students only need to scan their ID card. This makes the action of capturing student attendance data significantly faster. The existing system does not provide the student with an immediate indication that their attendance has been recorded. But in the proposed system, this is achieved with the RFID scanner, which displays a green light upon taking attendance. Unlike the previous system, where the student needs to use Student Services to acquire a form containing details regarding their academic course, the student can generate an attendance form from the university app or website. This report contains all details relevant to their attendance through their academic studies or for singular modules. This detailed report can then be used as proof for the Student Loans Company. It contains much more insight regarding attendance than just stating the student attended their studies full-time.

Lecturers and Module Governors: The lecturer played an integral role in the existing system as they had to provide the QR code to the class. This is different in the proposed system. They have a minimal role in capturing student attendance, only helping to process the ID number of students who have lost their ID card. The lecturers can now find a detailed report directly from the university website or app regarding their students' attendance, rather than having to request one to be made manually by the administration team.

Administration Team: The administration team held a substantial role before. They had to manually process the attendance data that were stored on the spreadsheet. This action is now automatically achieved by the data processing platform of the system. This means that collection and processing of student data and attendance data are achieved more efficiently. Unlike before, where the administration team would likely have to manually produce a report upon request, the system now automatically generates a report through the user interface. These factors indicate that much of the pressure that was exerted on

the administration team in the existing system has been alleviated. The data processing platform is still under the supervision of the administration team; however, most processes are now performed automatically without the team's involvement.
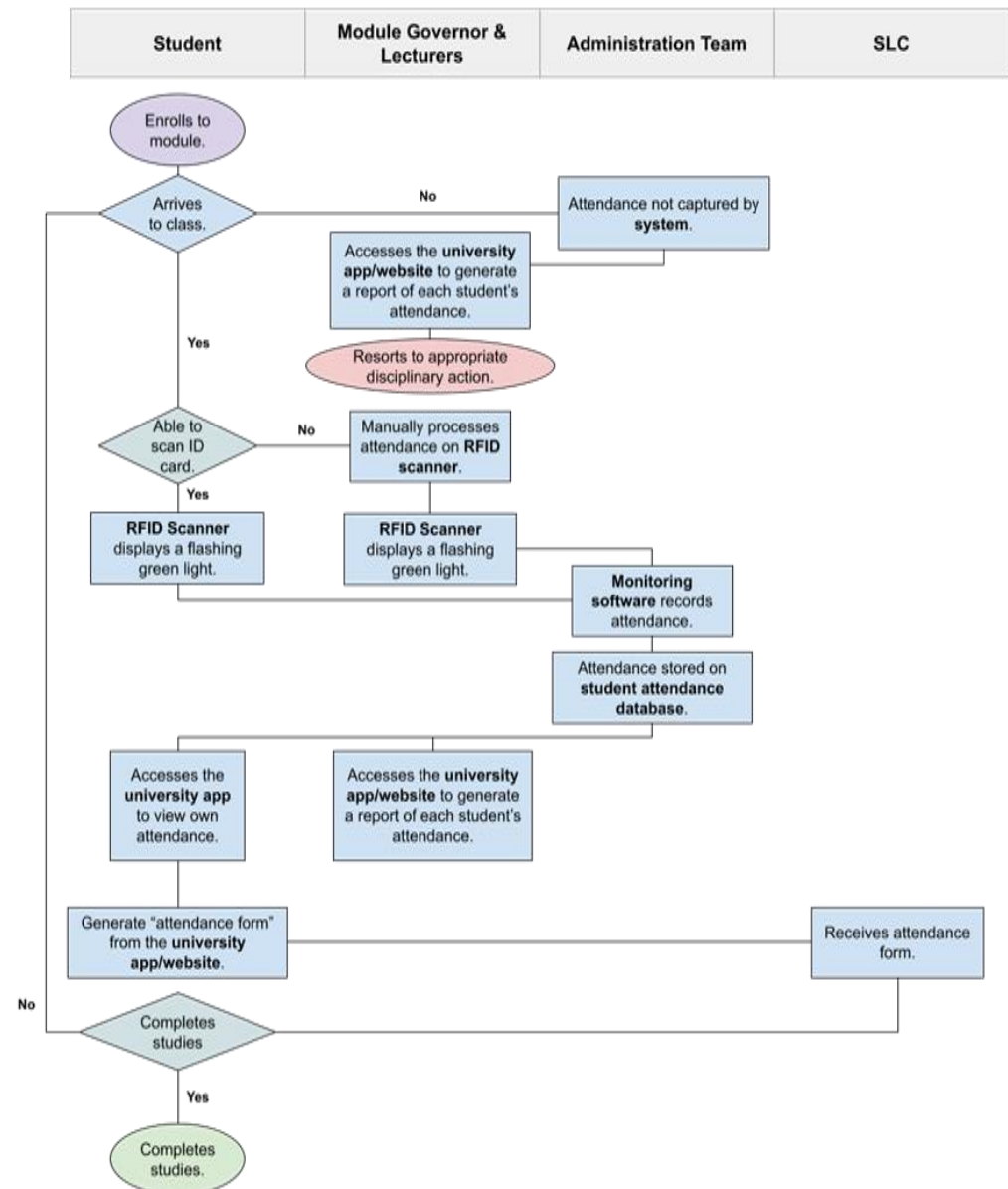

Figure 4. Example Process of the Proposed IS Solution.

3.2. Improvements Offered by the Proposed IS Solution

The proposed system offers various benefits over the existing one. In comparison to the existing system, capturing attendance is now achieved with minimal involvement of the lecturer or the administration team: the student only needs to scan their ID card on the RFID scanner. This makes the system easier to use for all users and captures attendance more efficiently. Not being very complex while being efficient were crucial system requirements. The new system now also clearly indicates when attendance has been recorded. This is achieved with the RFID scanner by flashing a green light upon recording attendance. This transparency can lead to increased trust in the system by both students and lecturers, encouraging them to make efficient use of it. Knowing when attendance has been recorded was another one of the system's key requirements. There is also a failsafe in case the student cannot sign in when they are missing their ID card. This was another key requirement

and is achieved by the lecturer by typing the appropriate ID number on the RFID scanner. This makes the system more sustainable by addressing potential limitations in recording attendance. In comparison to existing systems that may record the presence of a student by inserting the data on a spreadsheet, student attendance data are now directly recorded in a database. This means that the system is more secure in processing the students' sensitive information. It also means that less pressure is exerted on the administration team, as the system now automatically processes student data and student attendance data through the monitoring software. This makes the system more efficient in analyzing attendance and generating relevant reports. Both of these were key requirements. In existing systems, the students would have to reach out to the administration team or other relevant student services to acquire proof for student loan services. These forms were usually vague, only stating when the student attended their academic course and that they attended full-time. Now, students can extract this information directly from the relevant university application or through direct services via a dedicated website. This minimizes the involvement of the administration team/student services and suggests that the proposed system is more efficient. It also makes it easier for students to extract the information they need, as they can do this directly from the university app or website. This means the system is not too complex for the students to use. The Student Loans Company also benefits from this, as the form provided by the student can contain in-depth information from their attendance reports about the student's attendance through their academic course, across different modules.

3.3. Shortcomings of the Proposed IS Solution and Potential Recommendations

This section discusses shortcomings of the proposed IS solution. These shortcomings can be differentiated as internal and external. Internal shortcomings are about potential design flaws of the IS solution. In comparison, external shortcomings are more related to potential limitations based on what role users have within this system. A crucial internal shortcoming of the system is (the system) not taking into consideration when the student leaves a session they are attending. This is a drawback because it brings to question the validity of the overall output of the system. A student may leave their sessions early, which would be an indication of poor student engagement. However, their attendance would be captured in these sessions inaccurately, giving the impression that they are engaged in their studies. A potential way to work around this limitation is by adjusting the system to capture attendance when students also exit the class, with students scanning their ID card on the RFID scanner. However, this could potentially lead to further issues. It brings into question what the lecturer would do with students who entered these sessions without their ID card. Capturing attendance would be much more time-consuming when the lecturer needs to manually process the student on the RFID scanner both at the beginning and end of a session, which goes against requirements that the system be efficient and easy to use.

Another limitation is that there is no indication beyond the flashing green light from the RFID scanner to show that attendance has been captured. If the system fails to capture attendance due to an error and the green light flashes, the student will assume their attendance has been captured and they will not be able to prove their attendance later. This means that the validity of student attendance would be in question. A student who attends sessions would appear to have low engagement, which is not accurate. This could likely be worked around by integrating an additional way for students to be notified that the RFID scanner has captured their attendance. This could come in the form of a notification on their university app. However, integrating such changes could make the system more complex for users and could have an impact on its development cost. Being cost-effective was one of the requirements of the system, so the maintenance and development costs must be as low as possible for the university to integrate it into its services. As the monitoring software, one of the key system components, is developed by the university itself, it could require a substantial initial investment to develop it.

From a long-term perspective, however, maintenance costs would be lower, as the university would be familiar with how to operate the system and how to address potential problems that may occur. Additionally, developing a monitoring software program is not impossible. There are examples of other universities developing their own monitoring software. An example is the University of Purdue (United States), which developed the Learning Analytics Dashboard to monitor student progress and identify areas where students may be struggling [28]. A potential way to work around the high development costs could be to use an existing monitoring software package, though this could lead to high maintenance costs. The system is reliant on internet connection, which could be considered another limitation. This is because when the system has no connection, the lecturer would then have to manually record attendance for all students. This would likely have to be done on paper, which would mean the system would not capture attendance in a timely manner. A class may consist of over 50 students, and more students would mean more pressure on the lecturer. While there is no workaround to this limitation, the university should still be aware of it. Thinking of how to manually process student attendance on paper more quickly could help alleviate some pressure. However, it would bring into question how these collected data would be integrated into the rest of the system and how the additional adjustments to the system may impact its development costs.

Another quite important issue is that the system also does not address how attendance would be tracked for online lectures and seminars. It would be necessary to integrate an alternative method to monitor attendance online, such as the utilization of online attendance forms. In turn, this could have a further impact on the development costs of the system in integrating the specific tasks/functions. When students have to miss lectures due to personal reasons (e.g., being sick), they would also have to notify the administration team directly, as there is currently no way for students to do this through the system. Both the student and the administration team would operate outside of the system to capture student attendance, thus raising questions about the efficiency and complexity of the system. In order to work around this limitation, the university would have to integrate a way for students to report their absences. This could be done through the university app. This would bring additional functionality to the user interface and would allow students to report their absences without having to reach out to the administration team. However, this could have an impact on the development costs of the system.

In terms of external shortcomings, there are two, and these are associated with the roles of the lecturer and student in the system. The first is that the system cannot generate a report without the approval of the lecturer or the student. This would mean that the output of the system (e.g., attendance statistics on a report) would be unused, which would make these data unnecessary. This would bring into question the efficiency of the system. The only way to overcome this limitation would be by having the system automatically generate these reports and send them to users on a weekly or monthly basis. However, even in this scenario, it would be up to users to take information about attendance in these reports and use it as a basis to increase student engagement. The lecturers would need to use this information in determining where the students may feel less inclined to engage in their studies, and then make appropriate changes to improve engagement. The students would have to use this information as a self-assessment tool, to track their own engagement and to set their own personal goals. The second shortcoming is that as lecturers have a responsibility in manually processing students who are missing their ID cards, they would require training on how to operate the RFID scanner. The lecturer would have to know how to input the students' ID numbers on the RFID scanner to process their attendance. This could likely mean that development costs could be slightly higher, as the lecturers may require training before the system can be properly integrated into the university.

3.4. Ethical and Legal Considerations

There are various legal and ethical issues that also need to be taken into account in relation to the proposed system. One of the key issues to address is that the system needs

to comply with local data protection and privacy regulations. In the UK, the authority that oversees data protection regulations is the Information Commissioner's Office (ICO). According to the ICO, data protection is not only a legal obligation but also a fundamental right of individuals [29]. A business has the legal obligation to comply with both the Data Protection Act 2018 and the General Data Protection Regulation (GDPR) [29]. This means that the system has to be proactive in addressing the right to privacy and consent. The system handles information that is sensitive to students, namely their personal details and academic course-related information. In order for the system to address this issue, the university integrating the system would have to obtain consent from the students. The university can acquire explicit consent from students by having them sign relevant consent forms. This allows both for students to have information about their data being collected and the university the permission to use the appropriate student and attendance data for the system to function. As the system uses sensitive information to produce the attendance reports, it would also have to be secure. This is another key issue to address. Having a more secure system would mean the university prevents bad actors from tampering with both the data that are processed and the data that are produced. This would mean that the output of the system, the information on attendance and other related statistics, would be more accurate, which is one of the objectives of the system. The system is already secure with the implementation of a database to store student information as opposed to spreadsheets. Additional tools could be employed to make it more secure, such as data encryption. The administration team would be supervising the system, which would imply that they would have to monitor for potentially suspicious user activity and to prevent unauthorized access. However, this could be achieved from the system itself through functions such as intrusion detection, log management or security event correlation. Another legal consideration for the university integrating this system is derived from the monitoring software. The university would have to develop the monitoring software, which would likely be done through their IT department and could involve a substantial investment. This software would then be the intellectual property of the university. As a consequence, the university would have to file a patent to protect it. This can easily be achieved by filing a patent form through the UK government's Intellectual Property Office [30].

4. Conclusions

In a quite simplistic definitional attempt, "knowledge transfer" could be approached as the sharing or dissemination of knowledge and the provision of inputs to problem solving. It is a process that relies rather heavily on one entity or person sharing relevant information with a different party. In an undergraduate or a postgraduate setting, knowledge transfer is most commonly associated with attending a series of classroom lectures. Therefore, students' class attendance and maintaining their focus on the taught subject should be approached as prerequisites. Prior secondary research has correctly identified that there is a positive correlation between student attendance and student engagement. It has often been argued that changing teaching methods to be more engaging can enhance learning, student participation, critical thinking and problem-solving skills, as well as decrease absenteeism. It is worth highlighting that during the recent pandemic, there was a strong emphasis on online-only lectures. However, ordinary classroom lecturing remains the primary method of knowledge transfer. Even after the paradigm shift to "temporary online learning" caused by COVID-19, students still express a strong preference for regular classroom activities. When the attendance of a class is low, engagement also tends to be negatively impacted. Hence, the proposed IS solution relies on student attendance as the main parameter to measure student engagement.

In summary, the IS solution that is proposed is an attendance-monitoring software system that utilizes key components such as an RFID scanner and a data processing platform (consisting of a student attendance database, a monitoring software application and a server). There is a heavy focus on theory, with practical implementation steps to be followed at a later stage. In any case, when compared with or benchmarked against

the existing IT solution currently in use at HBS, there are important benefits identified, with efficiency standing out, but also a few limitations that could be overcome with some more effort. This system can be used to track the attendance of students across their different sessions. The information collected by this system can then be used by both the university and the student to reflect on what the student's engagement might look like. The university can use this information to identify potential areas (e.g., certain lectures or seminars) where student engagement might be lacking and can make relevant changes in hopes of improving it. In addition, the university can use this information to track students who are missing out on their lectures and seminars, effectively being disconnected from university life. The university can then take appropriate disciplinary actions against such students when necessary. Students can use the information collected by the system as a basis for setting their own future goals. They can use this information to determine what their progress and engagement in their studies might look like. The system allows users to effectively track attendance. However, it is up to the users to take this information and use it as a basis to improve student engagement. The proposed system offers an array of advantages over existing systems. There are still a few potential drawbacks, either in relation to stakeholders or specific design laws; however, some potential recommendations in addressing these have been identified and clearly need to be explored further. It should be clarified that this theoretical comparison was against an existing IT application, currently in service at HBS. It is crucial to highlight that a real-life working prototype of the proposed system must be built as soon as possible in order to fully evaluate the current theoretical results and at the same time provide the opportunity for fine-tuning of the overall design of this IS solution based on the identified shortcomings.

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