Cloud-based Web Application with NFC for Employee Attendance Management System

Sai Ba Oo*, Nang Hlaing Myat Oo†,Suparat Chainan‡, Arpha Thongniam§ and Waralak Chongdarakul¶
School of Information Technology, Mae Fah Luang University
Chiang Rai, Thailand
Email: *1nanghlaing.oo13@lamduan.mfu.ac.th, †5731301089@lamduan.mfu.ac.th, ‡suparataum12@hotmail.com,
§arphathongniam@gmail.com, ¶chwaralak@gmail.com

***Abstract*—Efficient employee attendance management leads any organizations to increase overall corporate performance and accomplish specific goals. Accurate employee attendance records are importantly used to control working discipline and increase worker's productivity. Manual attendance-time checking makes increasingly the expense of time-consuming and paper work of the companies. Human actions i.e. mistake at work, and fraudulent time keeping are additional hidden expenses which affect the productivity of the organization. Variation of the attendance policies set up in different companies make more complicated in evaluation of employee working hours. Hence, automated time-attendance management system is the key operational variables for enhancing the performance, and profitability. The attendance management system captures time-attendance data and serves the management of the employee working hour records. However, some existing time attendance systems have limitations in terms of identification speed, cost of system devices, real-time attendance monitoring, and flexibility of database storage size. In this paper, we introduce a cloud-based employee attendance management system using NFC technology. The proposed application provides several important operations such as captured attendance records using NFC, automatic time calculation, leave and overtime checking, working hours evaluation, real-time updated information access, and generating reports. The proposed system also offers online portal which allows multiple company user accounts, requires no special software to install, and provides more flexible data storage. The evaluation of user satisfaction shows that our proposed system is practically used and satisfied.**

Keywords: employee attendance; time attendance management system; NFC; cloud computing.

I. Introduction

Recently, most companies or organizations need the system to record employee attendance. The accurate employees attendance data is very necessary for maintaining the employees supervision and discipline. Traditionally, the employee attendance is manually used by the paper based attendance sheet. In this manual system, manager of the company hardly manages the employees updated information and evaluates their working hours and performance. In general, the supervisor adds working hours by using the employee time card and fill in the time sheet indicating number of working hours for each week or each period time. This process spends inefficient time consuming in attendance records calculation, employee time shifts management, every in/out time tracking, and high cost of the paper sheet [1], [2].

To improve the employee attendance tracking, there are various attendance management systems using current technologies for person identification i.e. Radio Frequency Identification (RFID) and biometric technologies such as fingerprint recognition. The biometric system is employed to validate the person authorization. However, there exist some limitations of the biometric system. The fingerprint attendance system has a problem of human physical contact. The fingerprint sensor usually touched by a lot of people may cause some disease infects. Dryness or dirty of the finger skin probably make inaccuracy of the matching results. The image captured of finger demands a large memory space so that the system has slow running time when the volume of employee data highly grows. The memory device used to store employee data in many separate locations make the data management more complicated. Additionally, the cost of the fingerprint system is relatively expensive. Several attendance monitoring systems using fingerprint technology were proposed in [3], [4].

On the other hand, the contactless attendance checking device i.e. Radio Frequency Identification (RFID) and Near Field Communication (NFC) technology give more efficiency of flexible data integration, and more efficient cost in commercial and industrial use. NFC is newer version type of RFID which is currently integrated with mobile devices in two way communication between NFC tags and reader. RFID itself is mainly used in identification and tracking applications i.e. inventory, package tracking, highway toll gate, baggage load control, while NFC is used for more sophisticated and data secure transaction i.e. person identification, payment system, or other contactless access control. NFC is also embedded in smartphones to support the new trends of life styles such as buying tickets, access the room lock, parking, check-in at the airport, and business cards exchanges. The NFC and RFID applications and implementations were described in [5], [6], [7].

Some other employee attendance systems using different technologies have been proposed. We compared them with respect to the fundamental parameters related to attendance checking environments. Three time attendance systems were discussed as follows. Firstly, Cloud-TA Time and Attendance System [8] uses the fingerprint reader to capture the employee data and transmit the data to server through Internet communication and also includes door lock control and data backup. However, the system has some limitations of the identification speed. For verifying a single fingerprint, it must check the one with all other templates stored in the database server that is time consuming [9]. Secondly, First Time Attendance Management [10] was designed for a small-size company

i.e. 10-20 employees. This application uses LAN-based and USB storage to transfer employee attendance data from the fingerprint scanner to the local server. It also allows manager of the company to generate and view the time attendance reports and manage employee information and their attendance records, however this module cannot be accessed online. Thirdly, the attendance system namely, UA300 system also use the fingerprint matching biometric technique, but it does not provide online service. Other related works using NFC and RFID for the attendance tracking were presented in [11], [12]. The proposed system uses the concept of NFC to control the attendance system wirelessly while maintaining the confidential and security of the system. In the application [11], NFC is implemented through RFID card. It uses a microcontroller to store database, RFID tag to store the identification data, RFID reader to transmit and receive data, and a Zip-Bee control wireless.

Since the employee and attendance information will be more effective if employees and managers can access real time from anywhere to manage and make a good decision [2]. Moreover, all industries can benefit by using the attendance system more flexibility and low cost in terms of hardware and software infrastructure. Therefore, the cloud-based time and attendance tracking system comes to our attention. Recently, the cloud technology has been integrated with the employee attendance system for more efficiency of data management though the visualization technology [13]. The cloud based system can be accessible through a web interface and all database can be stored on servers with more secure connection and regular backups. It also allows the data to be viewed, modified, report and analyzed. The research [14] proposed a cloud-based time and attendance system which allows employees to login and out over the web, enables employees and managers to monitor time and compliance, schedule staff, and run reports. The time and attendance system using several technologies i.e. Bluetooth, RFID, and NFC was proposed in [15].

As motivated above, we develop cloud-based application using NFC technology for employee attendance tracking namely *Time Attendance Management System (TAMS)*. Unlike other systems above, our application offers several stakeholder accounts. For commonly used in all level of employees, we begin using NFC card for indicating each of them. To meet the user requirements, the proposed application consists of the main features i.e. online access of employees and managers, capability of using the existing NFC card and scanners, no limitation of employees, no limitation of data storing, and generating reports. The main functions of our proposed system were compared with other time attendance management systems as shown in Table I.

TABLE I. COMPARISON BETWEEN THE PROPOSED AND OTHER SYSTEMS

System/Task	Cloud-TA	First time attendance management	UA 300	Our System
Online system	Yes	No	No	Yes
Scan NFC card	No	No	No	Yes
Report	Yes	Yes	Yes	Yes
No limitation Employee number	Yes	No	No	Yes
Available login for employee	Yes	No	No	Yes
No Limitation of data storing	Yes	Yes	No	Yes

To ensure that our proposed employee attendance management system can be used effectively and practically, the system has been tested by the target users. Therefore, our system specification has been adjusted until meet the desired requirements. The user satisfaction method is used to evaluate our proposed system performance. The result shows that our proposed system is practically used and satisfied.

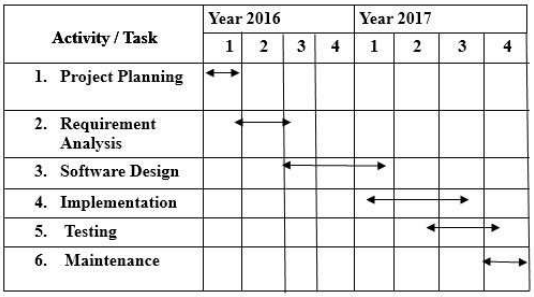

Fig. 1. Development plan of the proposed application

II. METHODOLOGY

In this paper, our proposed system has been developed based on the Software Development Life Cycle (SDLC) which is the one of the popular software development method. For the customer satisfaction, the proposed application was evaluated with Expectancy Disconfirmation Model.

A. Software Development Life Cycle (SDLC)

The SDLC is a process used to produce a high-quality software which meets the customer expectations within times and cost estimation. The development process of the proposed time-attendance management system is described in a series of seven main phases consisting of *planning, analysis, design development, testing, implementation* and *maintenances* as follows.

1) Planning phase: The development of the proposed application has been performed within 4 months as shown in the timeframe of Figure 1. Since the purpose of our system is to support the time attendance management of any organizations and their employees, we established the survey to collect the user requirements in the form of questionnaire. The result was concluded in Table II.

User Requirement The end user's needs and intended uses were gathered from several company managers and staffs as described in Table II. During requirement identification, we had taken into account two main system features consisting of input and output specifications. The Input part of the system is designed for the user registration, employee information management, and NFC tag data management. The output functions enable generating various reports, setting up clock schedule, and managing the company and employee data storage.

Functional Requirements The operation of the system for data manipulation and processing should include creating and modifying the user accounts and enabling search options of the employee details. Other specific functionalities should accomplish creating shift and associate policies, assigning shift to employees, tracking every employee's in-out time .

Non-Functional Requirements The qualification aspects of the system should be concerned such as performance

TABLE II. USER REQUIREMENT

Topic	Time Attendance Management System	
Actors	1.Manager 2.Official	**Actors**
Input Form	***Requirements***	
1)	Register Form	Company Manager and Employees
2)	Add employee information form	Company Manager
3)	Scan(Insert) NFC mac address into the system	Company Manager
Output Form	***Requirements***	
1)	Summary of weekly/monthly/yearly Report	Company Manager
2)	Table form of time check in/out/total hours	Company Manager
3)	Personal information of company and employees	Company Manager and Employees
Functional requirements	1.Able to create/delete user account	
	2.Able to edit/update user profile	
	3.Able to search employees'name , position	
	4.Able to request absence to work	
	5.Able to show table of check in/out, daily total hours, employs information	
	6.Summary of report	
Non-Functional requirements	1.Print summary of report	
	2.Forgot password	
	3.Log out automatically in 15 minutes	
	4.Help button	

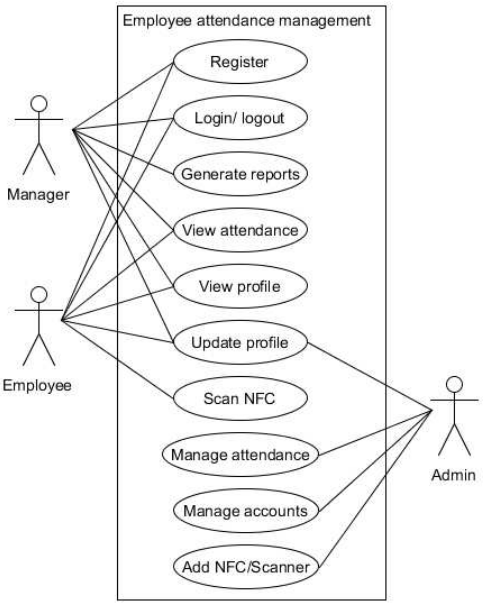

Fig. 2. Use case diagram of the proposed system.

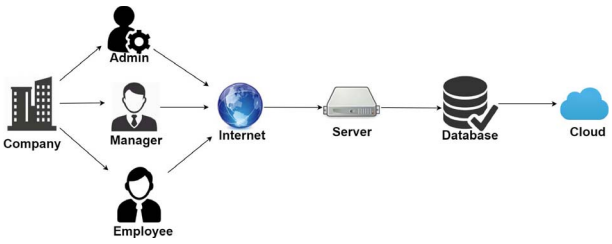

Fig. 3. Overview of the the proposed TMS architecture

requirements, security, or reliability. Based on the quality requirement, our system should provide the feature of system recovery and backup, automatically logging out after 15 minutes of none active use and the function to display help text, tips, or suggestions.

2) Analysis phase: At this phase, our system functionalities are defined. There are various main functions consisting of user registration, user login authentication, real-time attendance information view, company and its employee profiles management, attendance captures with NFC scanner, shift policy assignment, automatically calculation of leave, late, overtime from recording entries and exits, and generate reports.

A proper use case diagram describes a high-level overview of the relationship between the user and the different use cases to achieve the stated functions. The use case diagram in Figure 2 shows how the main components of the system interact with the involved people consisting of the company manager, employees, and system administrator.

Administrator: The administrator of the system is the highest level user. The administrator can manage user accounts and profiles such as approved changes to basic employee information (duty hours, type of duty, alternative work schedules, name changes, etc.). The other authorized users i.e. employee and manager are assigned by the administrator to do some specific tasks in the system. For the main features of the attendance management system, the administrator can create and perform the time keeping management together with the NFC technology. The personal identification numbers for each employee is assigned and stored in the NFC card given to the employee of the company.

Company Manager: Manager of any company can firstly register then login or out to the system. The important system features are provided for the manager i.e. creating and assigning separate shifts for different types of employees based on departments, defining the attendance policies, tracking every employee in/out time, and generating weekly, monthly, and yearly reports.

Employee of the company: With attendance monitoring module, an employee of any company can do the registration and receive an NFC card with an identification number. Every employee will use the NFC card to mark entering or leaving time stamps. They also login or out to view their own attendance records, profiles as well as update their personal information.

Since the proposed time attendance system is based on cloud technology, all users can access the application through the internet communication. The overview of the system architecture is described in Figure 3.

As mentioned earlier, the proposed system can be used in any companies or organizations to monitor their employees' working time with three user roles. When the employee scans the NFC card, all details of the employee attendance i.e. ID, photo, date, time-in and time-out is transmitted using NFC communication modes. The employee's identity is searched in the database with the scanned data. The system then validates the person information and marks the presence with the current data and time. The application can repeat the steps above for all present employees. The process is briefly explained in Algorithm 1.

Since the proposed time management application is devel-

Algorithm 1 Time Attendance Checking Process

```
Add employee data of a company.
Assign ID NFC tag.
while Departure time is not enabled do
    Read employee arrival time.
    Update database with arrival time.
    Display arrival time.
end while
if Departure time enabled then
    Read employee departure time.
    Update database with departure time.
    Display departure time.
end if
Calculate time elapsed.
Conduct attendance data analysis.
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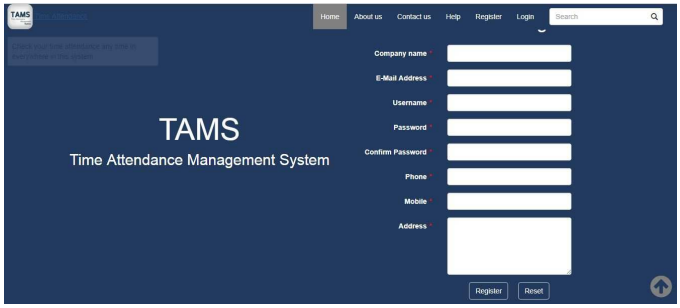

Fig. 4. Home Page of the System

oped based on cloud computing, the data storage is built using the enterprise Microsoft SQL Server which provides the application and database services on cloud. Our system is developed in the web-based application with user responsive interface design which supports the web site to display the same content to all devices with different styles of the resolution screens. Hence the users can access the application using any devices from any places.

3) Design Phase: In the design phase, the specific designs and workflows for our application to accomplish the user requirements are identified. The proposed system features are described in the user interface design and application architecture. The user interface should make the user interaction as simple and effective. To support our different types of user i.e manager, employee, and administration, the proposed application shows individual system appearance for each type of them after they login. Four pages to represent our important features are shown in Figures 4-7.

A. Home page: The first page of our web-based application provides the main features for accessing to the system i.e. the registration, login and logout, search, and the company contact as shown in Figure 4.

B. Attendance Records Page: As shown in Figure 5, this page is used to view the employee attendance records by all users. It shows the time tracking of employee's entry and exit in daily routine work. The month drop-down can be chosen to view the daily attendance listed in the duration of the selected months. The individual employee attendance information can also be searched and viewed in this page.

C. Employee Attendance Report: The employee attendance data is valuable for the companies as the data can be

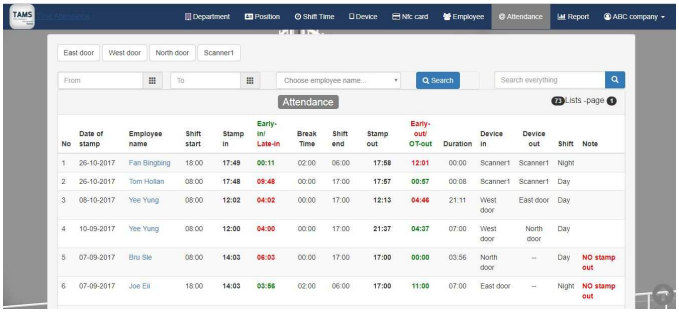

Fig. 5. Attendance record page

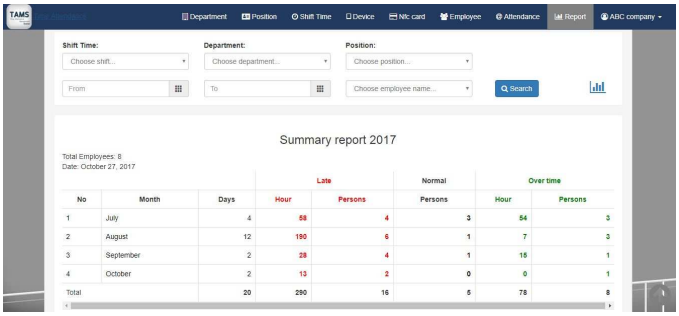

Fig. 6. Summary report page

generated the relevant reports as shown in Figure 6. Hence our proposed web-based application offers a wide range of reports to facilitate the managers to access real-time attendance data such as time in, time out, overtime data, late entry, early exit). The program also provides the list of reports with various filtering options i.e. summary report by Employee which provides a daily total of the hours for a specific employee. The attendance report can be produced in form of bar chart for the summary in weekly, monthly, and yearly as shown in Figure 7.

4) Development phase: Based on the previous system design documents, the application development is divided in modules and the coding is actually started. This phase includes building, installation, configuration, testing, and finding defects and error. Our program was written in PHP language since it is the open sources which provides reasonable and customized server cost. For simple implementation and maintenance, we use Model-View-Control (MVC) framework and MySQL database system allowing efficient code reuse and parallel

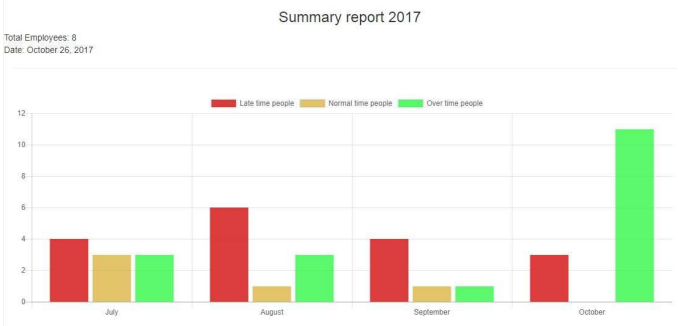

Fig. 7. Chart of Summary report

TABLE III. QUESTIONNAIRE FOR THE PERFORMANCE EVALUATION OF THE PROPOSED TAMS

No	Question
Navigation	
1	Clicking to other pages was easy.
2	Going back to home page from any page was easy.
3	Going to the default page from any page was easy.
4	The search at default page was effective.
5	The site has workable links.
6	The site has no dead-end pages.
7	Buttons word related to the destination page.
Organization	
1	The organization/structure of the site was understandable.
2	The organization/structure of the site is simple.
Ease of use	
1	Fast loading the sites pages.
2	Fast downloading excel file from the site.
3	Moving around the site was easy.
Design	
1	The site was attractive.
2	The images were appropriate.
3	The color were appropriate.
4	The pages design was attractive.
5	The text size were easy to read.
6	The layout was consistent.
7	The layout was easy to learn.
Content	
1	The daily date and time were quick importing.
2	The daily date and time have accurate importing.
3	The daily date and time were up to date.
4	The information was accurate.
5	The late time and overtime was clearly presented.
6	The information was clearly presented.
7	The reports are clear and understandable.
8	The reports were adequate.

development.

5) Testing phase: Software testing is investigated to present stakeholders about the qualification of the software product [16]. To ensure our proposed system having correctness and completeness, the software testing is performed by using Expectancy Disconfirmation model to measure the user satisfaction. The results to be considered include that the system should meet the owner requirement and satisfaction, and system improvement should satisfy the client desires after evaluation in terms of navigation, design, architecture and ease of use. The model was represented in survey which contains the questions corresponding to the expected result evaluation.

The survey with a Likert scale (5-point scale) questions is used to evaluate our proposed system performance. Our questionnaire ask the target users to give their quantitative value in five levels of agreement as follows.

level 5 = strongly agree
level 4 = agree
level 3 = uncertain
level 2 = disagree
level 1 = strongly disagree

The questionnaire contains 5 parts consisting of Navigation, Organization, Ease of use, Design, and Content as described in Table III.

6) Implementation phase: Once the proposed time attendance management system has been completed, we deploy the entire database and the application code on the cloud server. However some specific changes can be deployed in further.

7) Maintenance phase: After the application is in fully operation, the software may need to address changes in the needs of the company to correct bugs or security issues. During the maintenance phase, the proposed application may include programming updates, handling bugs and error, monitoring the system performance, and adding increased functions.

B. Expectancy Disconfirmation model

An expectancy disconfirmation model focuses on the gap between system performance and customer expectations. This standard approach refers to the evaluation of prior user expectations toward the observed performance of the proposed application. Therefore, the expectation and the outcome performance are two main parameters to be measured as the customer satisfaction results. Recently, it becomes popular in other scholarly domains such as information systems [17], [16], [18]. The evaluation of our system by using the expectancy disconfirmation model is described in Section III-B.

III. RESULT AND ANALYSIS

In this section, we explain how to get the requirement, collect the target user satisfaction from the survey and evaluate our system performance.

A. How to collect the user requirement

To implement the proposed application, we have collected the employee attendance data from the target user in the companies. The basic function associated with an Employee time and attendance system consists of multiple work schedules, attendance rules and policies, leave policies, overtime rules, supervisory review on-line or paper-based requests, global time entry and exit by timekeeper or department head, display on the time capturing device, shift schedule assignment, employee viewing of sick, leave, absences, and late statuses. For the system and integration, the proposed system should support the existing NFC devices of an organization, flexible software and database infrastructures with cloud system, and available for multiple organization user accounts.

B. Evaluation Results

The proposed application is evaluated in the form of questionnaire generated by the Expectancy Disconfirmation model. The questionnaires are collected by 22 respondents. The system should meet the client satisfaction in both of functional and non-functional requirements as shown in Table III. The scores based on the questionnaire respondents are measured by the user satisfaction model as shown in Table IV.

IV. DISCUSSION

In this paper, we propose the employee time attendance management system (TAMS) web-based application. The proposed system is introduced for facilitating the company to track and monitor its employees working hours as it monitors late arrivals, early departures, and time taken on breaks. It also provides the benefits of the accuracy of their payments as well as improving the employee productivity. The functionality of the proposed application was collected by the target users of several types of companies. The system performance was evaluated after development and deployment and the result

TABLE IV. THE RESULT OF THE USER SATISFACTION AFTER USING THE PROPOSED TAMS

Questions	Mean	Level of satisfaction
Navigation		
1. Clicking to other pages was easy.	4.59	Satisfied
2. Going back to home page from any page was easy.	4.59	Satisfied
3. Going to the default page (Time attendance page) from any page was easy.	4.33	Satisfied
4. The search at default page (Time attendance page) was effective	4.14	Satisfied
5. The site has workable links.	4.14	Satisfied
6. The site has no dead-end pages.	4.14	Satisfied
7. Buttons word related to the destination page.	4.14	Satisfied
Organization		
1. The organization/structure of the site was understandable	4.00	Satisfied
2. The organization/structure of the site is simple.	3.95	Satisfied
Ease of use		
1. Fast loading the sites pages	3.86	Satisfied
1. Fast downloading excel file from the site	4.00	Satisfied
2. Moving around the site was easy	4.05	Satisfied
Design		Satisfied
1. The site was attractive	4.00	Satisfied
2. The images were appropriate	4.09	Satisfied
3. The color were appropriate	4.00	Satisfied
4. The pages design was attractive	4.00	Satisfied
5. The text size were easy to read	4.05	Satisfied
6. The layout was consistent	3.86	Satisfied
7. The layout was easy to learn	3.77	Satisfied
Content		
1. The daily date and time were quick importing	4.09	Satisfied
2. The daily date and time have accurate importing	3.95	Satisfied
3. The daily date and time were up to date	3.95	Satisfied
4. The information was accurate	3.77	Satisfied
5. The late time and overtime was clearly presented	3.86	Satisfied
6. The information was clearly presented	3.77	Satisfied
7. The reports are clear and understandable	3.82	Satisfied
8. The reports were adequate	3.86	Satisfied

shows that the application satisfies all users in terms of Navigation, Organization, Ease of use, Design, and Content.

However, the time attendance application would be extended to allow the employees to taps their Android/iOS smartphones to the NFC identification tag to start counting time instead of using the NFC card. Additionally, The proposed system may not support tracking the working hours of the field employees who often work outside the office such as home service, installation technicians, home health providers, housekeeping, maintenance staff, delivery personnel and etc. The better options providing for the company is to allow employee to check in or check out on specified GPS location using their mobile phones.

V. CONCLUSION

This paper introduces the employee attendance cloud-based system integrating with the NFC technology, namely TAMS. The proposed application offers multiple company accounts each of which has its own company users. Our application provides online access of all users to manage the employee attendance data which allows users to view, modify, report and analyze. For more flexibility and lower cost of hardware and software resources, the cloud platform has been integrated with our system. Therefore the web interface and database are stored on the cloud servers with more access security and backups. To ensure that our application is in practical use, the system specification has been tested by the target users until meeting the functionality requirements. The performance of the application is evaluated by the user satisfaction model and the result shows that it has good level of user satisfaction.

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