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RADIO FREQUENCY IDENTIFICATION (RFID) SMART CARD ON PARKING SYSTEM AS E-BUSINESS PROSPECT

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Abstract

This research aims at presenting how RFID Smart Card technology developed in parking system as e-business prospect. The measured indicators are stakeholders' satisfaction. In addition to that, the increasing of income in parking unit after the implementation of RFID smart card is compared to that of the manual parking system. This research is a case study on a private university in Bandung. The method used is descriptive analysis by using questionnaires and direct data retrieval on related divisions as data collection techniques. Data collection was only done in the business unit of two-wheeled parking. Data were analyzed using validity and reliability test, and were assessed with Likert scale to be presented descriptively. The results supported the main idea that RFID smart card applied in parking system has decent prospects as e-business. The application of RFID Smart Card technology in parking system service showed a very high level of satisfaction average of 89,75% for the stakeholders. In addition, the percentage of income obtained from the parking system tends to increase by 150% compared to that of the manual. To improve the benefits of this research, further research on the use of RFID smart card associated with other e-business components in HEI such as e-learning and e-administration may necessarily be conducted.

Keywords: E-business, Higher Education Institutions, Parking system, RFID smart card.

1. Introduction

The use of RFID-based smart cards in the worldwide HEIs continues to increase due to its benefits and convenience [1]. In addition, RFID has been very popular due to its higher data integrity and accuracy than that of the barcode technology [2]. RFID is an automatic identification method that uses Radio-Frequency (RF)

electromagnetic fields to recognize objects that carry labels or transponders (tags) when getting closer to the reader [3, 4]. RFID is also a technology consisting of EPC (Electronic Product Code), NVRAM (user data storage), and RF systems allowing wireless data exchange of EPC and user data [4].

Relating to e-business, the use of Smart Cards for parking systems in the HEIs aims at improving services to stakeholders, increasing revenue, and enhancing marketing strategy opportunities [5]. It is also designed to improve convenience in terms of service, integrated information, cash flow, and to save labor and administration costs in HEIs [6]. Smart Card usage in HEIs is an e-business application via e-payment [7, 8], for example in parking system, admission, and registration [8].

Given the low use of RFID smart cards in HEIs in Indonesia as well as the fact that many researchers ignore their association with e-business colleges has initiated this research despite the fact that the existing consideration on universities as business is still considered taboo in Indonesia [9]. On the other hand, it is inevitable that HEIs has become a series in the business of education, moreover, many HEIs funded by society and its future depend on the number of the students registered. Therefore, income-generating activity is particularly significant so that universities can survive in the midst of intense competition. Realizing this, the concept of marketing began to be applied gradually to universities in order to gain competitive advantage and gain market share [10]. RFID smart card technology used in parking systems can be one solution for HEIs because it can increase revenue and improve operational efficiency [5].

Previous research on RFID Smart Cards has reported the implications of RFID Smart Cards without explaining specifically on how the technology used in Smart Card development can support e-business activities at universities. It is highlighted the Smart Card as an important part of the digital economy, without clearly explaining its relationship with e-business in college [11]. In the meantime, research on RFID smart card in parking system with explaining more on the technology without associating it with the income for HEIs keeps increasing [4, 12]. It is also claimed that utilizing RFID for smart parking has given benefits to parking operator and parking place users. However, the research did not present the exact calculation on income percentage of parking operator nor the satisfaction of parking users [13-18]. Therefore, this study is different from the previous study in terms of the description on the application of RFID Smart Card to parking system in a university and how its technology develop as one of the e-business applications by measuring both of income percentage of university's parking unit and stakeholder's satisfaction. The report will result the benefit from both side (parking operator and user).

In a case study in a private university in Indonesia, RFID Smart Card is given to stakeholders, i.e., lecturers, employees and students. This card serves as identity cards for academic and student administration activities, parking system in campus, lecture attendance system, and library lending system. In the parking system, the use of smart cards aims at improving the convenience of motor vehicle users and improving the security at the same time. Additionally, its relation to e-business can also increase income and reduce fraud management of parking funds that occur in the field [5].

2. Experimental Method

2.1. The level of stakeholder satisfaction in the parking system

This research is a case study conducted in Universitas Komputer Indonesia by distributing questionnaires containing 15 statements on September 25, 2017. Additionally, data were also obtained from the documentation of the collected reports from related divisions. The stakeholder satisfaction level was measured on 100 respondents, calculated by Slovin formula [14]. The population of this study was all stakeholders parking their motorcycles in the campus area (Basement and front parking lot). Based on the data, the average number of daily parking users in two places during September 2017 was as followed Table 1.

Table 1. Population of parking user.

No.	Location	User
1.	Basement	2500
2.	Front parking lot	1000
	Total	3500

The determination of sample size in this study was calculated using Slovin formula [14] as $n = \frac{N}{N\,(d^2)+1}$, where n is the number of sample unit, N is the number of population unit, d is the Real level 0,1 (α = 1%), and *1* is the constant number.

Based on the Slovin formula, the sample size can be written as

$$n = \frac{3500}{3500\,(0{,}1^2)+1} = = \frac{3500}{3500\,(0{,}01)+1} = n = \frac{3500}{36} = 97.22$$

In accordance with the results, the sample of this study is 97.22 rounded into 100 parking users. To determine number of sample on each parking area, the formula of proportional random sampling was used [13] as $= \frac{Ni\ x\ n}{N}$, where Nh is the number of samples of each unit and *Ni* is the number of sub-population of each unit.

Based on above formula, the sample calculation of each parking area can be illustrated in the following Table 2. Table 2 illustrates how the sample is formulated in order to reach a proportional sample. The sample mentioned was taken from two areas of the parking lot.

Table 2. Number of samples on each parking area.

No.	Parking area	Population	Proportional Sampling	Sample
1	Basement	2500	$\frac{2500\ x\ 100}{3500} = 71$	71
2	Front page	1000	$\frac{1000\ x\ 100}{3500} = 29$	29
TOTAL		3500		100

The calculation of the correlation coefficient of Pearson should be performed for validity testing stage using the following formula:

$$n\,(\sum XY) - (\sum X).(\sum Y)$$

$$rxy = \sqrt{\{n\sum X2 - (\sum X)2\}.\{n\sum Y2 - (\sum Y)2}$$

where *rxy* is the the correlation coefficient, *X* is the total item score, and *Y* is the amount of total score (all of item).

Then, criteria for decision-making in testing validity are:

(1) If *r* count > *r* table, then the statement is valid

(2) If *r* count < *r* table, then the statement is invalid

The critical value of Pearson is 0, 197. *r* count on all statements that all *r* count > *r* table so that the data is declared valid [13]. Furthermore, reliability testing (reliability level of the questionnaire) is calculated by using Cronbach Alpha formula [13, 14]: $r_i = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum \sigma_b{}^2}{\sigma_t{}^2}\right)$, where r_i is the reliability instruments, k is the number of questions, $\sum \sigma b^2$ is the number of grain variants, and σt^2 is the total variant. Criteria for decision making in reliability testing are defined if the instrument has a reliability coefficient of ≥ 0.6 [16]. Based on the results of data processing, the reliability value obtained is 0.828, which exceeds the reliability coefficient of 0.6, so the statement is included in the category of reliable [13].

2.2. Parking income level (e-business parking unit)

To measure the level of parking income, the collection of annual parking income data is collected from related divisions. Data from 2013 (using the manual system) is compared with that of 2014 to 2017 (using RFID Smart Card). The income in 2013 is used as a benchmark and is illustrated in graphics.

3. Results and Discussion

3.1. Design of parking system

This study examines the use of RFID smart card EM4100 model with a frequency of 125 kHz in an HEI. It is an automatic identification device that has two components: a. RFID tags (transponders) consisting of a small device embedded in a book such as labels that have unique identification and writeable memory, and b. The RFID reader, which is a contactless communication device with a tag to identify when, connected to a wireless data association on a radio frequency [7].

The RFID reader used on every parking door is a link between the application software and the antenna that will radiate radio waves to the RFID tag (transponder). Identification of objects or data on RFID technology is done by matching the data stored in the transponder tag memory with the data sent by the reader. RFID is formed by the main components of the reader-tag and the passive tag antenna as well as being placed on the object to be identified. In the passive tag, the reader through electromagnetic waves sends the signal, and then the tag will respond and transmit the data [15].

The type of RFID tag used in this research is the EM4100 / 4102 passive tag because this tag is easy to obtain and has a small shape like the card. It can be produced at very cheap cost because it does not require battery power. This passive tag gets power from the electromagnetic energy emission process derived from RFID reader. In general, this tag has 8 unique IDs on each tag and will be detected when read by RFID reader. This RFID tag has the following specifications: a. 80 mm Reading Distance b. Using GK4001 chip c. Using frequency 125Khz (GK4001) d. PVC Materials e. Operating range -40 to 70 degrees Celsius f.

Resistant to water E. Database setup In database system design for I / O is created using Visual Basic 6.0 software [5]. Before establishing the GUI (Graphic User Interface), firstly create a place to store the database using SQL server.

Parking system using RFID is illustrated in Figs. 1 and 2. When vehicle user is to set RFID card to reader, parking system will check RFID ID in database. If the data is found in the database, the bar will open automatically and the data of the incoming vehicle will be saved automatically into the system. When exiting the parking lot, the system will check into the database whether the user' RFID ID is used for parking or not. If the database is found, and the amount of balance in RFID is sufficient then the bar will open and the balance amount is reduced automatically. If the balance is insufficient, the parking bar will not open and must be opened by the officer after the user pays the parking fee.

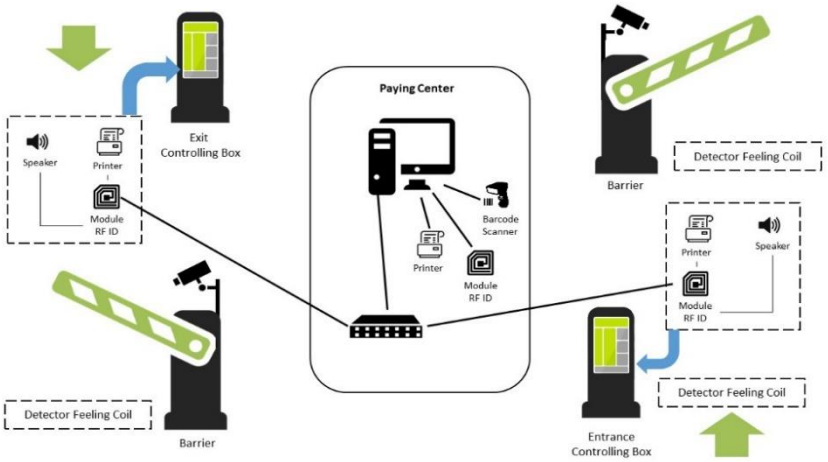

Fig. 1. RFID-based parking system.

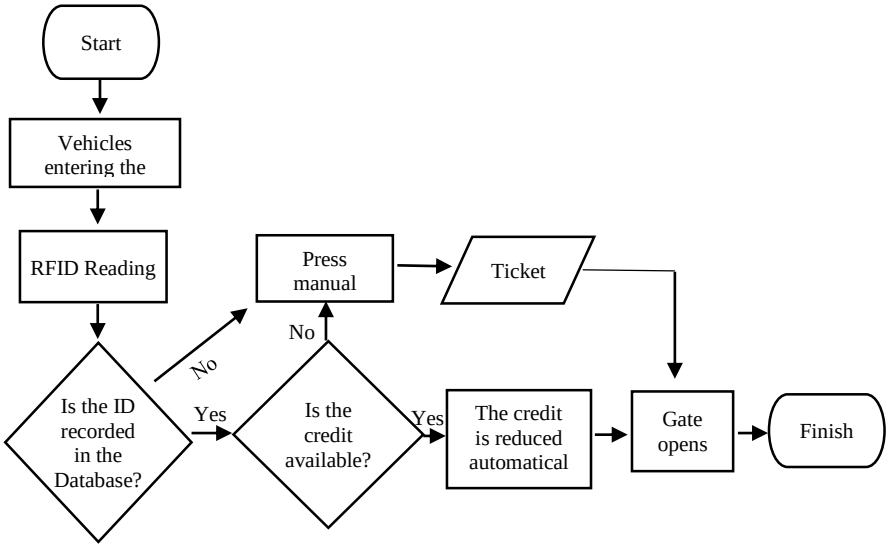

Fig. 2. Work chart of RFID based parking system.

Parkhi et al. [12] claimed that the RFID parking system was better in terms of user authentication compared to wireless sensor networks, Zigbee, Bluetooth parking system [4], whereas Rahul et al., claimed that RFID technology in university parking system gave high reliability and high speed inventorying of the data compared to the barcode technology. This research describes the design and all component of RFID parking system to complete the previous research. It also provides information concerning software and tools support to develop RFID system and as a consideration for the investment in building RFID parking system in HIEs.

3.2. Analysis of stakeholder satisfaction level in the parking system

Each statement on the questionnaire was given a score according to the Likert scale on Table 3. The total score of 15 statements filed in the questionnaire is 6371 and the ideal score of 15 statements is 7500 so the% actual score is calculated by dividing actual score with ideal score. Thus, % actual score is (6731/7500). Or, the value can reach 89.75%.

Table 3. Weight of Likert scale value [16, 21].

Sample	Value
A	5
B	4
C	3
D	2
E	1

To categorize the respondent's assessment of the satisfaction level of the parking system with RFID smart card (Fig. 3), categorization is made by calculating the interval spacing for 15 statements on 100 respondents, as follows:

Minimum Index Value = Minimum Score x Number of Statement x Respondents
= 1 x 15 x 100 = 1500
Maximum Index Value = Maximum Score x Number of Statement x Respondents
= 5 x 15 x 100
= 7500
Interval = Maximum Index Value - Minimum Index Value
= 7500 - 1500
= 6000
Interval Range = Interval: Scale
= 6000: 5
= 1200

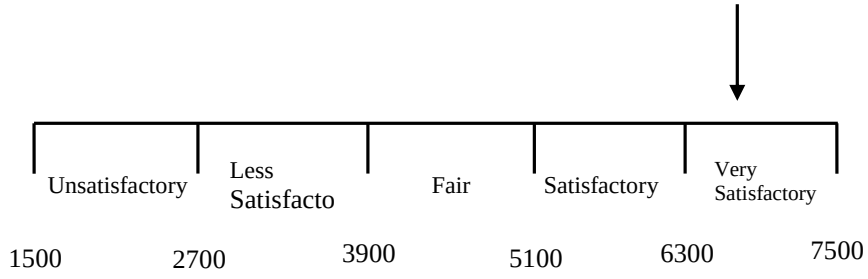

Fig. 3. Percentage of satisfactory level.

From the results of the questionnaire analysis with Likert scale above (See Table 4), it appears that all respondents are very satisfied on the use of RFID smart card on the parking system in the campus area with the actual score of 6371 from the total score of 7500, equivalents to 89.75%.

Table 4. Percentage of Likert Scale [16, 21].

Answer	Remarks
0% - 19.99%	Unsatisfactory
20% - 39.99%	Less satisfactory
40% - 59.99%	Fair
60% - 79.99%	Satisfactory
80% - 100%	Very satisfactory

The high level of satisfaction resulted in this research shows that RFID smart card in parking system greatly improve the efficiency and effectiveness of service delivery. Relating to e-business prospect, the use of RFID is highly recommended since the e-business for HEIs is foremost in improving service to their stakeholders [7]. Very satisfactory level also shows that the utilizing of RFID in parking system has contributed to profitable relationship engagement between HEIs and its stakeholders, furthermore HEIs have managed to identify the need of stakeholders and created value for them in terms of parking service. It is very important because the failure to identify their needs can create serious consequences for HEIs [17] and probably will not survive in a competitive market [18].

The use of RFID presented in the previous research is claimed beneficial in the terms of its advanced technology without presenting its correlation with e-business. Smart card application can create added value to the university [6, 11, 12]. The previous research also claimed that RFID smart card contributes benefits for the parking operator and parking user [18]. However, to the best of the author's knowledge none of the past research has described the real calculation or presented number to measure the word of "beneficial" and "value" in e-business terms.

3.3. Analysis on parking income level (e-business parking unit)

As shown in Fig. 4, the increase in income in 2014, 2015 and 2016 in parking units increased by an average of 150% after using RFID smart card when compared to that before using RFID in 2013. The income figures shown in percent and income in 2013 serve as a benchmark for comparing additional revenue after using RFID in the parking system.

RFID smart card technology in parking system has increased parking income significantly with 150 % and has shown that the advanced technology can make a better management in parking fees collection and prevent fraud in the field, thus RFID smart card can increase security and safety [19]. The calculation of parking income in this research can help HEIs to consider the investment of RFID parking system. In the future, the recorded database may serve as evaluation management in terms of parking income in each semester. Therefore, the pattern of income can be investigated annually in order to determine investment for improving the quality of parking infrastructures [20, 21]. It is claimed that RFID based automated toll collection system is cost effective and sustainable [22]. Some researcher published their research that the smart card system and technology make overall parking

operations more cost effective and add value for costumer [5]. Another research showed that RFID system can increase the revenue [23]. Most of the previous research showed that RFID smart card in parking system and its application in transportation field is very effective in terms of cost both from costumer and provider side. Unfortunately, how much exactly its effectivity can increase revenue never been discovered. Therefore, this research attempts to present the exact percentage of the increasing of parking income by comparing RFID parking system and manual parking system.

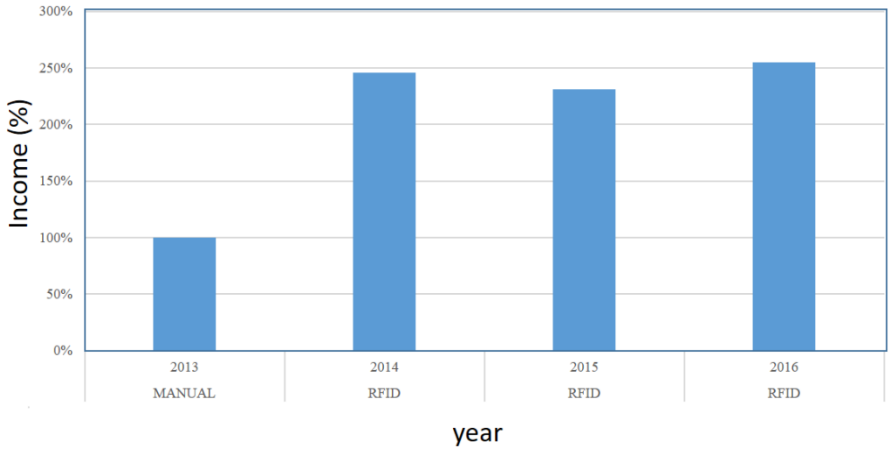

Fig. 4. Parking income.

Despite the benefit of RFID system, it also has drawbacks. The RFID is affected by metal and water, which is possible to cause malfunction. Tag collision may occur if a reader picks up signals from multiple tags at the same time. Reader collision may be an issue if two readers interfere with each other's signals [24]. In correlation with the satisfactory level, the sudden malfunction can make queuing time is longer and time consuming. The other drawback of RFID parking system, it also brings up some security issues. Unauthorized devices may be able to read and even change data on tags without the knowledge of the person who owns the object. Side-channel attacks can pick up RFID data as it passes from a tag to a reader, which could give the attacker access to passwords or information that should be secure. Some states have privacy statutes to restrict activities that might use RFID technology to collect personal information [25].

4. Conclusion

Focusing on RFID system as e-business that contributes mutual benefit for both users and provider, parking system in HEIs has greatly impacted upon the users and provider. Impact to the users was described in the level of stakeholder's satisfaction which reached 89.75% qualified as very satisfactory. Impact to the provider was described in the increasing of parking income that reached 150%. Particularly, provider may benefit more on the income management that there will be less fraud occurs in the field due to digital implementation of the parking system. Not only that, RFID parking system has proven to provide good service in its implementation and therefore will lead to excellent image for the HEIs through words of mouth affecting

stakeholder attitudes. This may then be a high strength on HEIs marketing strategy. In the future, using more sophisticated infrastructures, RFID parking system may be extended into an integrated device, such as the use of cellular phone for multi-payment for services offered in the HEIs.

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