A Prototype Design for Electronic Payment System for Universities

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***ABSTRACT**: Developing an Electronic Payment System (EPS) for universities to handle tuition payment is a complex task since factors such as stakeholders problems, culture, cost and communication infrastructure must be addressed in finding system solutions. This paper presents a framework for developing such a system by highlighting the development methods and the model for system solutions. The proposed system has been implemented and used by nearly ten thousand users (students and parents). The results of the evaluation (based on the KSF defined) indicate that the proposed system has achieved all of the target indicators.*

Keywords: University Electronic Payment System,Tuition Payment System, IS Development Framework.

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1. Introduction

Following the current regulations [4,7], Indonesian universities must implement the course credit system. Undergraduate and graduate students must complete a certain number of course credits to obtain degrees. Every semester during students' enrollment, they must register for courses, each with a certain number of credits. Then, students must pay a certain amount of money depending on the number of credits, labs, studio, assistantship, tutorial, etc. registered. As there are thousands of student payments that must be handled each semester, managing these has not been an easy task. If not handled properly, student payments every semester may not be balanced, students may not meet the payment due date, causing loss to universities. On the other hand, if the system payment does not satisfy student and parent requirements (user friendliness, convenience, etc.), they may complain not only to the university management but also to the public at large. This may degrade universities' "brand image" and bring about loss. Fortunately, by taking advantage of IT, universities may implement the Electronic Payment System (EPS) as a solution for providing better services (for students) and increase management efficiency.

Developing EPS to handle tuition payment is a complex task, due to the fact that student or parent behavior and needs in paying bills, university management requirements, IT infrastructure, products offered by banks and their collaboration must be addressed. Despite the urgent need of universities for proper EPS, through literature study, we have not found any research result that present a detailed method in developing EPS suitable for universities. Therefore, this paper is intended to contribute a framework of the methods in developing EPS, specifically for Indonesian universities by highlighting the methods of development and the model for system solutions. The university selected for this study is Parahyangan Catholic University (Unpar), which currently employs 9668 undergraduate and graduate students.

The paper is presented in the following order: literature study of EPS, the proposed developing methods, system model, evaluation of the system developed, and a conclusion.

2. Literature Study

An electronic payment is defined as a payment service that utilizes ICT, including cryptography and telecommunications networks [6]. EPS is classified into cash-like systems (e-cash), check-like systems (credit card and credit-debit based systems), and hybrid systems (stored-value card based systems). Currently, hybrid systems could be implemented as online payment, which has the advantages of efficiency, convenience and flexibility, while having the barriers of privacy, security and reliability [2].

Khosravani [3] states that in order to be successful in implementing EPS, users' awareness must be increased so that they are encouraged to use it, and be assured that the system is secure and comprehensive. Infrastructure to accommodate high quality telecommunication facilities must also be provided. [8] presents findings from a survey to identify customers' attitude towards a new payment service, which are usage (score: 0.990), perceived ease-of-use (0.922), perceived usefulness (0.898) and behavioral intention to use (0.889). [9] and [6] present the significant criteria in system evaluation, which are security, cost, convenience and universality (includes payment type and interoperability across systems). [6] suggests that to increase customer interest, they should be able to choose the payment instrument with the lowest cost. Customers must also be able to keep track of the balance.

The payment system trend to be considered in developing EPS is described in [5]. Ten years ago, online banking meant that customers could view their account online, any time of any day. The next generation added the ability to pay bills from a PC desktop or via telephone or mobile devices. Now comes what could be called the third generation of online banking: accountto- account (A2A) payments between a customer's accounts at different banks.

Based on the literature study conducted, it could be summarized that in designing EPS, the most important issues to be addressed are efficiency, convenience, cost, flexibility or universality, privacy, security, reliability, customer interest, and infrastructure.

3. Methods for Developing University EPS

After studying the literature concerning EPS and conducting surveys in the universities and banks, we found that the information system development life cycle (SDLC) as described in [1] needs to be enhanced so that it is suitable for the EPS development. Here, as shown on Figure 1, we propose the framework of the EPS development for universities, which consists of 8 steps. To increase student and parent interest in using EPS, on Step 1, cultural issues are identified and used in defining the system objective.

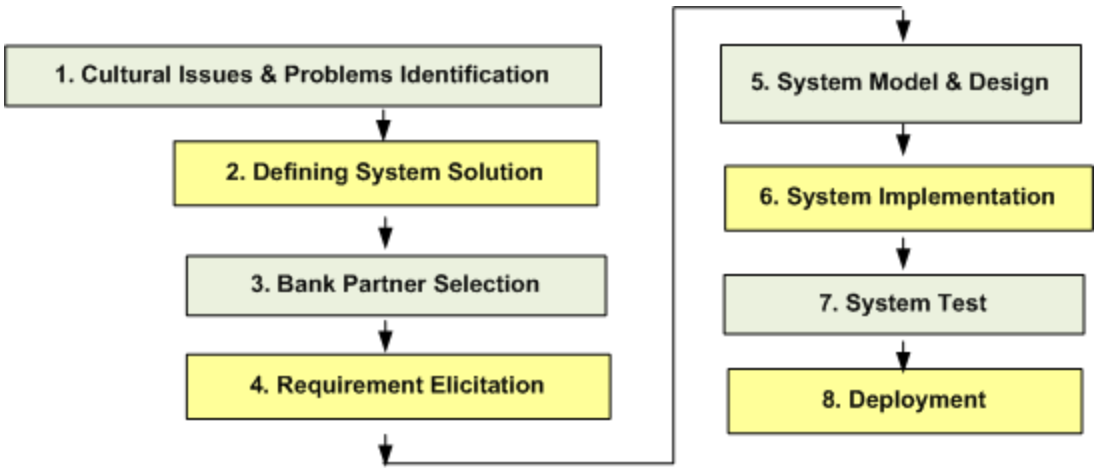

Figure 1. The steps of the proposed methods

Due to space limitation, this paper discusses Step 1, 2, 3, 4 and provides an overview of system model and the result of system evaluation.

4. Cultural Issues and Problems Identification

Traditionally, the method of payment that has been practiced for years in Indonesian universities is that students pay tuition by transferring or crediting to certain university bank accounts by writing students data (ID, name, address) in the message. Applying this method has caused several serious problems as outlined in this section.

Problems faced by university managements:

P.M.1. It is hard to perform payment monitoring (who has paid, who has not) as the payee identification (student ID) or remitter is sometimes unclear. There have been mistakes in identifying students who have not completed their bills and otherwise.

P.M.2. The balance between the total number of due bills and actual payments each semester is hard to achieve as it is hard to impose academic sanctions regarding late and incomplete payment.

P.M.3. The summary and detailed payment transactions are sent daily by the bank (to the university), and manual reconciliation (between checking account and the transactions) is lengthy, slow and potentially erroneous.

P.M.4. The rate of late payments are high as the result of weaknesses in imposing fines and academic sanctions.

P.M.5. Students' inaccurate amount of payment (could be less or more than the due bill). Problems faced by students and parents:

P.S.1. Inconvenient in carrying the hardcopy bills (given to students) to banks or ATM. If the bills are lost, they must request a new bill that requires physical attendance and sometimes standing in a queue.

P.S.2. Students must keep the receipt to prove that they have made the payment for payment checking before course registration. If the receipts are lost, they must inquire about the replacement that takes days to process (by the banks).

P.S.3. Sometimes students receive false bills, especially in the case of scholarships received where the amount must be deducted from the tuition bill.

In order to provide a useful payment system solution, as stated in [8], user behavior must be considered. Based on our years of observation and learning from payment data statistics, the following are the cultural and habits that must be addressed:

C.S.1. Most students or parents have desire for easy, fast methods of payment that could be accessed any time from any where.

C.S.2. Many students like to pay on the last day of the due date which could case long queues if payment should be made at the limited counters, booths or banks.

C.S.3. Many students like to postpone the payment due to various reasons.

C.S.4. Many students do not meet the payment deadline although applying the fine for late payment has been implemented.

C.S.5. Students and parents hesitate to pay the total bill at once at the beginning of each semester. They want partial payment with an acceptable lag time between payments.

C.S.6. Many students and parents bank with many banks, and hesitate to take and deliver cash tuition payment.

C.S.7. Students and parents are not happy with the transaction charge.

C.S.8. Students and parents are not happy if their payment transactions are known by others.

5. System Solution Definition

Based on the problems and cultural issues previously discussed, the objective of the research is to build an EPS, which couldbe classified as hybrid-systems (as found in [6]), that addresses the problems and issues. Table 1 maps the problems, related issue as stated in the Literature Study section and the system solution. As stated in [9], security is the most important factor of EPS. Of all 9 security criteria [9], we select 7, which are suitable for the university EPS. The criteria for the Key Success Factor (KSF) and target are given in Table 2.

6. Bank Partner Selection

Selecting the bank(s) that meet the KSF criteria is the most important step as many issues (reliability, security, cost, etc.) are actually resolved by the products offered by the selected bank. Here, in selecting bank partners, two stages of the "filtering" process are conducted as described below.

First: Candidate bank selection. By considering the criteria in Table 2, the prospector bank partner must:

Problem, Culture/Habit	Issue	Description of System Solution
P.M.1, P.M.3,C.S.1, C.S.2, C.S.6.	Efficiency, Convenience	Online EPS that could be accessed anytime from anywhere (any bank), having real time transaction reports.
P.M.2, P.M.4, P.S.2, P.S.3, C.S.3, C.S.4, C.S.5.	Efficiency, Flexibility,	EPS integrated with Academic MIS which has features as follows: (1) Students who have not completed their due bill could be given academic sanctions accordingly, while those who have completed would gain access to course registration, viewing grades, etc. (2) Student bills are computed based on registration data and scholarships received which are valid in the current semester.(3) Student bills are generated twice (before each semester and in the middle of the semester), due dates are defined for each bill, therefore students or parents do not pay the whole tuition at once.
P.M.5, C.S.3	Reliability	EPS with exact but partial payment (it accepts the payment which is equal to the bill amount) that guarantees the accuracy of transactions.
P.S.1, C.S.8.	Convenience, Privacy	EPS providing feature for accessing and paying bills personally via various devices (computers, smart hand phone, etc.)
C.S.7	Cost	EPS for free of charge or minimum charge of transaction.

Table 1. Description of the proposed EPS.

No	Issue	Criteria	Target
1	Cost: investment	The cost of infrastructure and information system development is affordable.	Less than USD 15,000.
2	Cost: operational	System maintenance could be handled by one staff/ operator.	Less than 10 hour/week of staff working hour.
3	Cost: customer transaction	Additional charge for online payment	Zero.
4	Convenience	System availability & easy access.	Anywhere, anytime (multi-bank payment).
5	Customer interest	The users use the system.	100% of students or parents.
6	Scalability	Number of maximum payment transactions that could be handled in a day.	All users make the payment transaction anytime at the given period of time. No fail transaction.
7	Reliability	Bill statement accuracy.	100% at any time.
8	Reliability	Transaction accuracy.	100% at any time.
9	Reliability	Balancing between bills and payments	Guaranteed 100%.
10	Efficiency	Payment transaction data transfer.	Real time(time lag is a few seconds).
11	Flexibility	Partial payment.	Twopaymenttransactions/semester.
12	Privacy, security	Bill and transaction could be collected by students or parents who have the right to obtain them.	No breach, no complaint from users.
13	Security	Provide or guarantee identification, confidentiality, authentication, data integrity, non-repudiation, customer solvency, durability [9].	All of the criteria achieved.

Table 2. KSF criteria and targets for measuring the success of EPS

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First: Candidate bank selection. By considering the criteria in Table 2, the prospector bank partner must:

(1) Have a fine reputation for its security and reliability in handling millions of customer accounts and transactions (issues addressed: scalability, security and reliability).

(2) Have many branches throughout the country and establish a network that integrates the branches (issue addressed: convenience).

(3) Have an established communication network with other banks that facilitates money transfer (across banks) through ATMs, e-banking and SMS banking (issues addressed: convenience, efficiency, customer interest).

(4) Offer payment system products that facilitate payment anywhere anytime, as well as exact payment with minimal charges (issues addressed: flexibility, cost).

Based on the bank requirements, we examine the portfolios of many banks in Indonesia. There were 6 banks (namely A, B, C…,F) that passed the first "filter".

Second: Selection of the winning product. We conducted a survey of each bank to review the products. In general, there are 3 products offered by the banks in Indonesia, which are Virtual Account with Open Payment (VA-OP), Host to Host with Exact Payment (H2H-EP), and Virtual Account with Exact Payment (VA-EP). We then assessed and compared the products, analyze the feasibility of the technical implementation, the cost of implementation and the transaction cost. As a result, the winner is Bank C product, which meets the criteria stated in Table 2:

(1) Offers a payment product, VA-EP, where every student is given a virtual account (VA) as the destination of tuition payment. Every VA would receive only the exact amount as stated on items of bill payment where the items could be the breakdown of the bills as well as the total bills (the bills would be sent by university system directly to the VA-EP system), therefore mistakes of less or more payment are eliminated. As an account, every virtual account could be credited through the bank's teller, ATMs, clearing, e-banking and SMS banking via wide bank networks.

(2) Offers real time data transfer of payment transaction through the free leased line which has been established between the university and Bank C. Therefore, the main communication infrastructure issue is solved.

(3) Offers no extra charge for students and the university for every credit transaction made into VA.

7. Overview of Requirement Elicitation

Now that Bank C, with its specific payment product offered, has been selected, the detailed university policies related to student tuition payment could be made. Other important issues, such as the interface between Electronic Payment System (EPS) and Academic Management Information System (AMIS) could be defined.

Payment Policies. The university policies concerning tuition payment are:

(1) The total tuition bill for each semester is broken down into two bills: (a) Bill-1 contains the registration fee and total tariff of 10 course credits (applied to undergraduate students) or 5 credits (applied to graduate students). (b) Bill-2 contains the total bill for the semester (computed by summing up registration, credits of courses, labs and assistantship fee) deducted by the amount of Bill-1 and scholarship given (by the university or other institutions), if any.

(2) Bill-1 is due on a certain date before course registration at the beginning of each semester, and Bill-2 is due on a certain date before the mid-semester exam.

(3) If any bill is not paid before the due date, fine is computed for each bill, namely Fine-1 and Fine-2.

(4) If for some reason, students could not meet the payment of the on going semester, the total bill and fine would be summed up and stated as Due-bill.

(5) The bill items (Bill-1, -2, Fine-1, etc.) and total of the bill for every students should be available online and could be accessed anytime and anywhere as the reference of payment.

Academic Policies. In order to avoid late tuition payments and unbalance between total bill and payment, the academic

policies are:

(1) At the beginning of each semester, students who have not completed Due-bill and Bill-1 are not allowed to register for courses. Those who want to delay the payment would have to follow certain procedures to obtain approval of payment delay.

(2) In the middle of each semester, students who have not completed Bill-1 and Bill-2 are not allowed to attend course exams. Those who want to delay the payment would have to follow certain procedures to obtain approval of payment delay.

(3) At the end of each semester, students who have not completed the total bill would not receive their grades.

Interfacing Between EPS and AMIS. In order to generate the correct bills for students and put the universities policies into effect, EPS and AMIS need to exchange data as follows:

(1) In the last month of each semester, AMIS sends the data of active students to EPS for Bill-1 and Due-bill computation. After the final course registration period, AMIS sends registration and scholarships data to EPS for Bill-2 computation.

(2) EPS sends data of generated student bills and payment transactions (on real time basis) to AMIS which used to enforce the academic policies through features in AMIS.

8. System Model

The overall payment system that resolved the requirements consists of 3 large systems, which are AMIS, the university Payment System and the Virtual Account System (VAS) with exact payment. The first two systems are owned by the university and the last is owned by Bank C. The systems are connected through intranet and internet as shown on Figure 2 and could be accessed by various communication devices.

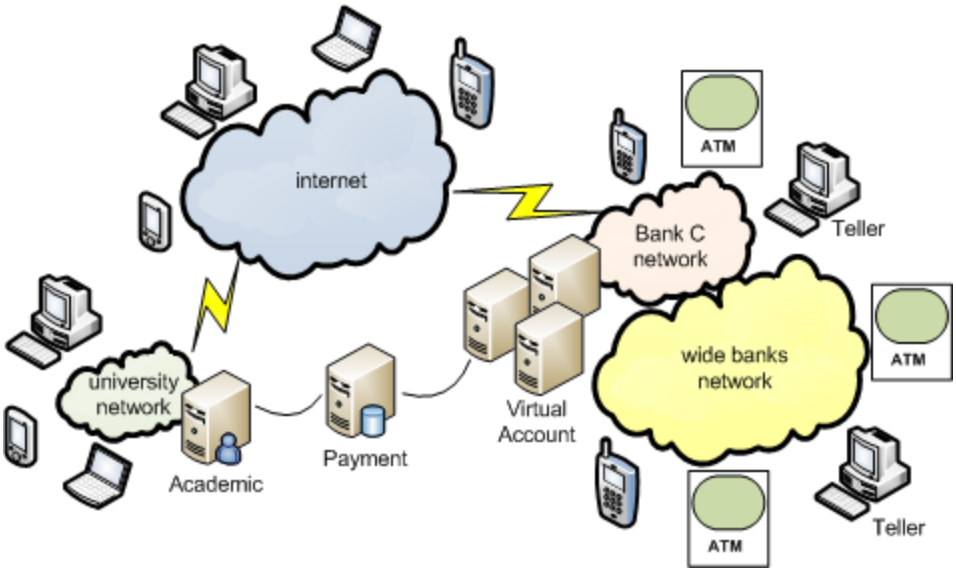

Figure 2. Payment system architecture that incorporates three large systems

The system components as shown in Figure 2 are:

(1) Academic MIS (AMIS): provides functions of course registration, posting tuition bills, etc.

(2) Payment System: provides functions of bill computing, communication (with banks VA server), payment parsing and processing.

(3) Virtual Account System: Bank C's large and complex system that handles various complex tasks, such as managing client account, credit transactions, communicating with other banks systems, clearing, reconciliations, etc. Banks C provides a website providing data reconciliations such that the university could access it and download the data anytime.

Procedures of the system:

(1) Students or parents access the bill through the AMIS network and pay the bill via ATM, e-banking or teller of various

various banks from anywhere. Every time a payment is made by a student or parent, the transaction is passed to PS.

(2) PS sends student payment to AMIS.

(3) If due date of Bill-1 is passed, PS generate Fine-1 for students who have not completed the payment and send the fines to the bank's VAS.

(4) Any payment made to VAS will be sent to PS on real time basis, then PS passes it to AMIS.

As stated in the Requirement section, AMIS and EPS exchange data described in Figure 3, the contents of each data is given in Table 3

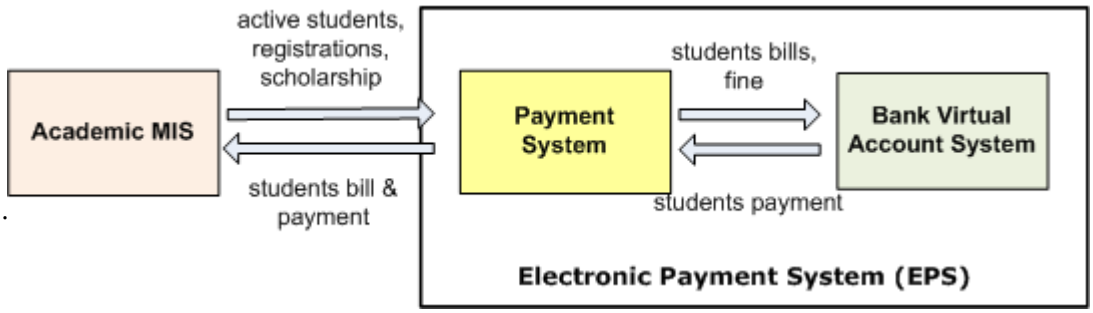

Figure 3. Data transfer between systems.

Data	Description	Data Attributes
active students	List of students who potentially continue to enroll courses for the next semester.	Year, semester, department ID, student ID, name,status.
registration	List of students' data course registration.	Year, semester, department ID, student ID, student name, course ID, course name, credits, lab, studio, assistantship, tutorial.
scholarship	List of students receiving scholarship for the semester.	Year, semester, department ID, student ID, student name, scholarship ID, name, amount of scholarship (used to deduct the bill tuition)
students' bill	List of students' bills.	VA_Id, Bill_Id (includes: student ID, name, year, semester, bill item), bill amount.
students payment	Student payment.	Transaction ID, Bill_Id, time, amount paid.

Table 3. Data transferred between AMIS and EPS

9. System Evaluation

The proposed EPS has been built, implemented and used for one semester (the 2nd semester of the academic year of 2009/2010). All of the 9,668 students or parents have utilized EPS successfully.

The excerpts of the qualitative target measurement made in January 2010 is the following (see KSF in Table 2):

The results of target measurements indicate that target 1, 2, 3, 4, 5, 6, 9, 11, 12 and 13 are achieved 100% with the following remarks:

(1) Target 1: the university spent about USD 12,000 to build the system.

(2) Target 4: A total number of 8,347 active students and parents paid tuition through banks ATMs (the most), e-banking (few) and tellers.

(3) Target 6: 9,388 transactions were handled during the period of payment.

(4) Target 9: there are "surplus" of credit coming from 2 "redundant" payment transactions (currently, this is under

investigation).

(5) Target 13 (security): student ID which is included in the student ID number has guarantee the transaction identification, the transaction is known by the student or parent and the university (confidentiality is assured), each transaction has its own unique authentication, no payment transaction was tampered, the exact payment method has guaranteed non-repudiation and student solvency, detail of transactions details can be verified both by university management and students (online).

The targets not fully achieved are as follows:

(1) Target 8: Achieved for 99.85%. Of all 9,388 transactions, Bank C reversed 14 transactions due to late response from the university server (no acknowledgement received after a certain period of time).

(2) Target 10: No data could be presented here. We were having difficulties in measuring lag time between the transactions submitted (via ATMs, e-banking, tellers, etc.) and the data received in our server. However, since the data transfer between the university server and Bank C server was smooth all the time and we receive no complaints from any student, we assume that the target has been achieved.

As an additional evaluation, we provide the qualitative comparisons of the proposed VA-EP system to other payment systems in Indonesia, which are VA-OP and H2H-EP (see Section 6) presented in Table 4. The VA-EP system has one weakness, which is the flexibility (allow few exact payment transactions each semester) compared to VA-OP (allow free partial payment transactions).

No	Issue	VA-OP	H2H-EP	VA-EP
1	Leased-line	No	Yes	Yes
2	Investment	Low	Higher	Higher
3	Unbalance problem	Unsolved	Solved	Solved
4	Real-time	No	Yes	Yes
5	Multi-banks	Yes	No	Yes
6	Transaction cost	Low	Low	Low
7	User convenience	High	Low	High
8	Flexibility	High	Low	Med

Table 4. EPS Comparison

10. Conclusion

Although the stages of developing EPS for universities could be the same as EPS for other institutions, the detailed tasks at every stage might be unique. At first, not only problems faced by stakeholders that should be elaborated, cultural issues must also be considered. In defining the system solution, all of the problems and issues must be addressed and defined as KSFs. Bank partner selection is the most important stage as the selected bank product solves many issues. Only after the bank partner and its service product are selected could the following stages (requirement elicitation, development of system model, design, etc.) be elaborated as the solutions in each of these depend on the product.

In this article, the evaluation of the model proposed is so far presented qualitatively in terms of time, money and security. Further work is needed to analyze the model thoroughly based on these terms so that the strengths and weaknesses of the model could be presented in more detailed.

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