The Design And Development Of A Cashless Payment System With An Automatic Identification And Data Collection (AIDC) Technology

Cris Norman P. Olipas, Dr. Rubelyn M. Esperon

Abstract: This study aims to design and develop a Cashless Payment System with Automatic Identification and Data Collection (AIDC) technology in an educational institution in the Province of Nueva Ecija, Philippines to understand the processes and activities undertaken to develop the project. It utilizes a descriptive and developmental method of research involving parents and students as the respondents using purposive sampling method. The system was developed following the stages of the Incremental Model of software development and was assessed based from the International Organization for Standardization's 9126 software criteria. The system passed the assessment made by the respondents and was viewed as an effective alternative to cash-based payment transactions.

Index Terms: Automatic Identification and Data Collection (AIDC), Barcode, Cashless Payment System, Incremental Model, ISO 9126

1 INTRODUCTION

The advent of technology has brought significant changes in the way how people live. It has been evident in the past decades where the rise of industrial revolution has caused radical and dramatic development in different aspects and facets of human lives. This has been supported by [1] stating that technology has revolutionized the world. The prevalence of innovative products and enhanced services had made people want for more, thus strive to seek for better ways of performing things. Technologies contributed so much in different domains of the society, making people change their way of living, of thinking about and doing things, and how they see the world [1]. Further, different technologies have simplified the process of performing different tasks [1] and procedures that has been complex and tedious over the past decades. Though the third industrial revolution has introduced the use of computers and microcontrollers, today's generation has further enhanced this and continuously improved and innovate things, hence industry 4.0 was born. Truly, technologies have made significant mark in people's lives. Sharma [2] asserts how technology has changed the lives of many people in different ways. In view of that, one of the changes was the improvement in the way how education works. Through technological innovations and different tools, the access to education has increased, allowing a larger number of people to have the opportunity to learn. Access to quality education has been extended to those who have difficulty in acquiring education. Through distance education, for example, people are enable to acquire knowledge and learn new skills with the use of innovative educational tools and instructional materials. The mode of learning has become more flexible and the interaction between teachers and students went beyond the four walls of the classroom.

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Different types of online tests and assessments were also developed to cater the different needs of the learners, and the increasing demand to teach life-long skills has been supported, thus it has been apparent that technology has changed the way education works [3]. Through the years, technological innovations have affected the way how people communicate [2]. This is another evidence how technology have affected people's lives. Elektrarna [4] cites that new media has replaced traditional media, traditional marketing was replaced by digital marketing, the rise of BYOD or Bring-your-own-device has been observed, collaboration in the workplace has been intensified, and communicating with friends and family members become much easier. However, negative effects of technology in relation to communication was also observed. For instance, relationships can be easily ruined because of the easier means of communication brought by technological advancements. The ways how technology changed communication was supported by [5] affirming the positive and negative effects of technology and how it has changed the way people interacts. Apart from education and the way how people communicate, technology is also making a difference between business processes and systems. Gilkey [6] mentioned several differences between the two, underlining the impact of technology and how it affects both in different means. Bourgeois and Bourgeois [7] supports this and explains the impact on the advent of technology. They asserts that information technologies has had a huge impact on how organization designs, implement and support business processes. Cloud computing for instance [8], [9] brought so much potentials in different organizations in the coming years. Because of this, negative and positive impacts of such technology can be observed in the workplace productivity [10] causing changed of behaviors [11]. In addition, [12] explains that while technology brings so much benefit, the future is still unpredictable to small business owners. To lessen the negative impact, it is important that the small and medium enterprises utilize technology effectively and efficiently. Since technological innovations and advancements has continuously increased, the lifestyle of many people has also changed. Stojanov [13] cites the impact of technologies in the daily lives of many people resulting to some dramatic changes. Positive and negative habits were developed, but [14] underscore how technology keeps people hooked resulting to some negative effects caused by digital addiction. This has been supported by the [15] recognizing the fact that

there is a serious growing problem of digital addiction. Google has launched a project which acknowledges the importance of well-being to raise awareness on the importance of good state of mind, and the entire well-being of individuals. Because health has been also affected by the technological advancements and developments, people has also developed how technologies can changed healthcare for the better. Hendricks [16] and Elezaj [17] explains the benefits of technologies in the healthcare industry citing that it can affect data consumption, improved communicating health related information, establishment of portal technology, enhancing remote health monitoring, accelerated experimentation, and development of mobile applications in support with different medical processes. Felt [18] in an occasional paper provided an idea on technology, health and healthcare further supported by [19] explaining the impact of technology in better dispersal of healthcare methods. However, [19] reiterates that while technologies in the healthcare industry has provided several benefits and positive impact, the use of the combined method of manual and automated process still plays a significant role in providing better healthcare among different group of people. On the other hand, some claims that technology has affected how people critically think. It has been cited that different technological advancements have contributed to the way how people think about things. For instance, the emergence of social media and different social networking sites have caused people to become victims of deceiving and fake news, disregarding the need to think logically, and judge the merit of the content of articles and the like [20], [21], [22]. While it is true that technology has greatly affected different areas and domains of the society, it can be noted that technology influence the youth so much that new innovations continuously thrives because the younger generations are exposed and well-rounded on the use and effects of technologies [23]. Automation has been evident alongside with the continuous improvement of technology. It is done to simplify tasks and to utilize the potentials of technologies. Groover [24] asserts that automation enhances the way how human perform their tasks and reduce the level of inaccuracy, incorrectness, and inefficiency. The development of different types of Information Systems are proof of how automation plays a vital role in the success of an organization. It has been a valuable tool for different types of organization in the achievement of their overall goals and objectives. Information systems are adopted and implemented in different industries such as healthcare, engineering, business, education, etc. In the education industry, today's era calls for more innovations and technologies not only on the manner of delivering quality education to the learners, but also the means on how to support other institutional services so that students would have a more meaningful educational learning experiences. One of the applications of technology in the education industry was the development of different information systems and technologies. An automated cashless transaction system can be consider as one of those applications that have a significant role in delivering student services and support in an academic institution. Subramanian [25] and Hock-han and Hyan-boon [26] have undertaken studies about cashless payment systems in different context to describe the effect of adopting such system. Subramanian [25] cites that an electronic payment system has been proven to be an effective medium in replacement to paper-based payments like bills and cheques resulting to a more efficient manner of conducting payment transactions. Hock-han and Hyan-boon [26] supported this by asserting that a casless payment system has significant impact in the economic growth of an organization in the long run, thus it has been promoted to adopt such technology which can have a significant impact in the future. Other studies involving electronic payment and other cashless payment systems have supported these claims indicating that a shift from a cash-based to a cashless payment system can bring significant positive impacts to different organizations and business entities [27], [28], [29]. Exisiting available projects and systems have utilized several devices such as Radio-Frequency Identification (RFID) and Barcode Readers to support the process of performing cashless payment procedures but literatures have shown that there is still a need to conduct studies in order to contribute to the existing body of knowledge. This study has been conducted to contribute to the exisitn body of knowledge in relation to the design and development of an information system so that the practices and procedures undertaken would serve as a reference for future researchers wanting to conduct similar study. Also, this study would contribute to the pool of studies relating to the design and development of a cashless payment system which could result to refinement of available, and providing additional support to the existing studies for future references. Lastly, this study would fill-in the gap of conducting a design and development of a cashless system using an automatic identification and data control (AIDC) technology such as barcode reader.

1.1 Statement of the Objectives

In general, this study aimed to design and develop a Cashless Transaction System with an Automatic Identification and Data Collection (AIDC) Technology.

Specifically, it sought to describe:

1. The design and development activities of the Incremental Model with the following stages:
   - 1.1 Planning;
   - 1.2 Requirements Analysis;
   - 1.3 Design and Development;
   - 1.4 Testing;
2. The assessment on the technical qualities based from the ISO 9126 standards with the following criteria:
   - 2.1 Functionality;
   - 2.2 Reliability;
   - 2.3 Usability;
   - 2.4 Efficiency;
   - 2.5 Maintainability;
   - 2.6 Portability;

1.2 Scope and Limitations of the Study

The study attempted to design and develop a Cashless Payment System with an Automatic Identification and Data Collection (AIDC) technology such as Barcode. The study tried to provide a solution to the existing process of conducting cash-based payment transaction in an educational institution. It followed the stages of the Incremental Model but was limited only to the following stages: Planning, Requirements Analysis, Design and Development, and Testing. The deployment stage was not covered since the researcher only focused on the design and development of a prototype system.

2 METHODOLOGY

2.1 Research Design

The descriptive and developmental method of research was utilized in this study to describe the process of designing the system and to explain the process of developing the project. Olipas [30] explains that a developmental method is essential to guide in the actual development of a system. Further, it covers a systematic approach from designing, developing, and evaluating the output. Coupled with developmental method, the descriptive method was also utilized to systematically describe the process of developing the project. It further answers the what, when, where, and how questions related to developing the system [31].

2.2 Research Locale, Sample, and Sampling Procedures

This study was conducted in an educational institution in the province of Nueva Ecija, Philippines composed of a total of 30 respondents that includes 15 parents and 15 students to asses the technical qualities of the system based from the users' perspective according to ISO 9126 standards. The respondents were selected using a purposive sampling technique. Crossman [32] explains that a purposive sampling is used to acquire data from a group of respondents who have passed the criteria set by the researchers.

2.3 The Instrument and Analysis of Data

The instrument used in this study was adapted from Olipas [33]. The developed system was assessed based from the ISO 9126 standards with the following criteria: Functionality, Reliability, Usability, Efficiency, Maintainability, and Portability. The questionnaire was a four-point likert scale assessing the level of satisfaction on the technical qualities of the system.

Table 1 *presents the scoring rubric and guide used in this study.*

Numerical Rating	Qualitative Rating	Verbal Description
3.25 – 4.00	Very Good	The system meets all the quality standards of software development. No or very slight adjustment is needed.
2.50 - 3.24	Good	The system meets almost all of the quality standards of software development. Slight adjustment is required.
1.75 – 2.49	Fair	The system meets the average quality standards of software development but requires major revisions.
1.00 – 1.74	Poor	The system fails to meet the quality standards of software development. Needs to be redone to serve its purpose.

3 RESULTS AND DISCUSSION

3.1 The Design and Development Activities of the Incremental Model with the following Stages:

3.1.1 Planning

The planning stage plays a vital role in the success of developing the cashless payment system. This stage was essential to properly lay down the plans and the activities to be conducted by the researchers in designing and developing the project. Olipas and Villanueva [34] cites that the main goal in the planning stage was to develop a solid foundation in order to come-up with the plans vital in the development of the project. Different planning tools are available to help the reserchers in executing the activities in this stage. One of the commonly used tool in the planning stage is the Gantt chart. A Gantt chart is used to track the progress of a project to guide the researchers and the developers. Through Gantt chart, the timeframe of a project was clearly presented and properly understood. Other data gathering tools and techniques were also utilized in this stage to help the researchers refine the data needed for the designing and developing the cashless payment system. It include observation, interviews, and extensive review of related literatures and studies. The results of these activities were essential in the success of the planning stage undertaken by the researchers.

3.1.2 Requirements Analysis

Requirements are essential and important to gather and properly analyze before the actual design and development of the cashless payment system. Requirements, according to [35] are very crucial in the overall success of the project. It is important that the requirements are carefully and thoroughly analyze because one wrong result of requirements gathering and analysis may cause a huge impact in the overall quality of the project. In the requirements analysis stage of the incremental model as used in this study, the researchers identified the necessary requirements for the design and development of the system. The requirements for designing the back-end and the front-end of the system was identified as well as the important features and processes that must be included. The requirements identified were the basis for checking if the developed project met the set requirements for the cashless system.

3.1.3 Design and Development

This stage of the incremental model includes the important activities undertaken by the reseachers of this study. The results of the planning and the requirements analysis stage were the basis for the design and development of the cashless payment system. The Use-Case Diagram (see fig. 1), Data Flow Diagram (DFD) (see fig. 2a and fig. 2b), Entity-Relationship Diagram (ERD) (see fig. 3), and Database Normalization (see fig. 4) were designed in this stage to properly execute the development of the cashless payment system using AIDC. Figure 5a and Figure 5b presents the user interface of the development cashless payment system.

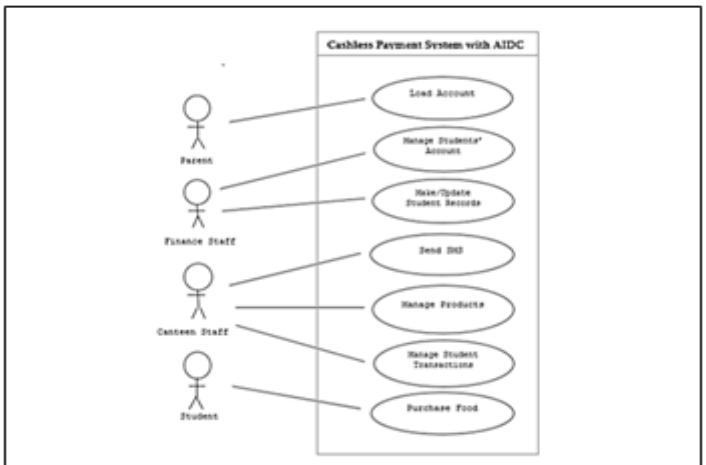

Fig. 1. The Use -Case Diagram consist of the *actors* involved in the system and the processes which they are allowed to perform.

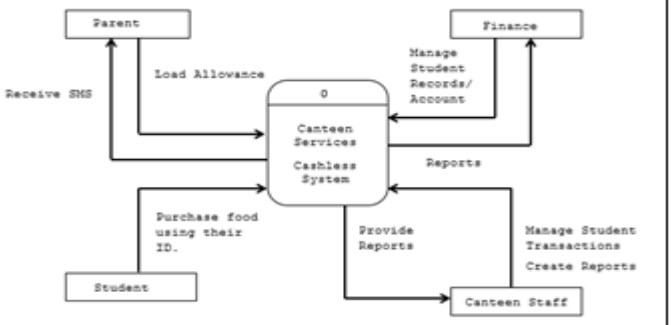

Fig. 2a. The Context Level in the Data Flow Diagram of the Cashless Payment System involving the entities: Parents, Students, Finance Staff, and Canteen Staff. The context diagram explains the general view of how the data flows from different entities going to and from the system.

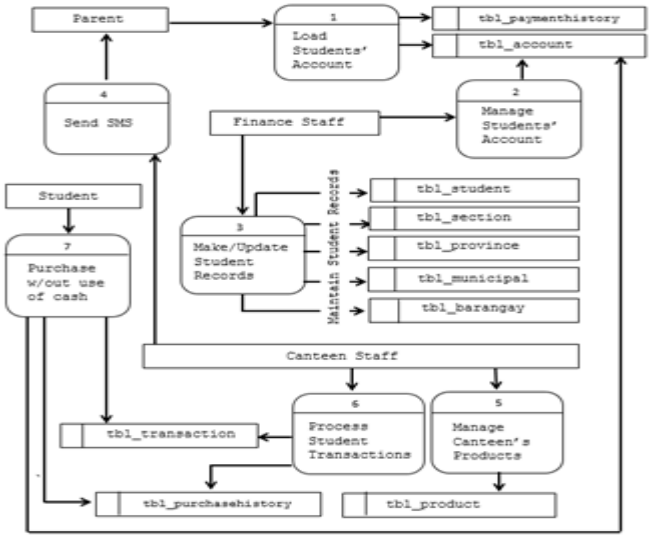

Fig. 2b. Figure above shows the Level 1 of the Da ta Flow Diagram. The figure presents a more detailed flow of information and the processes included in the cashless payment system.

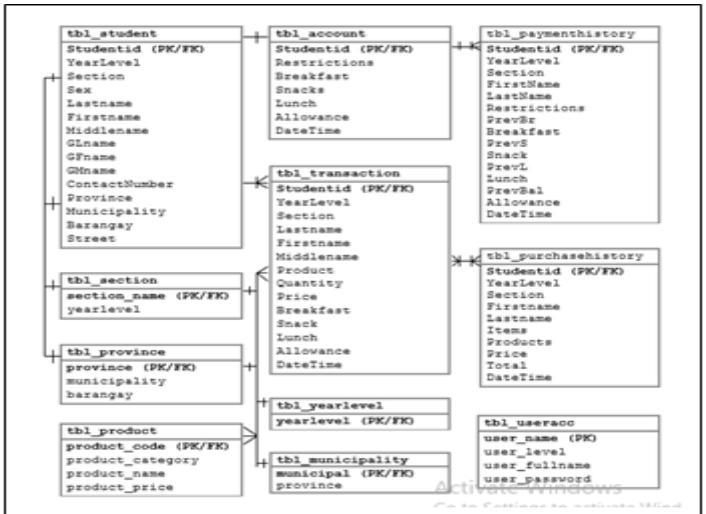

Fig. 3. The figure above shows the Entity -Relationship Diagram for the design and development of the cashless payment sy stem. It consists of tables and their relationship to other tables as reflected in the database of the system.

Fig. 4. Figure above is the third normal form of the database normalization used in the design and development of the cashless paymet system.

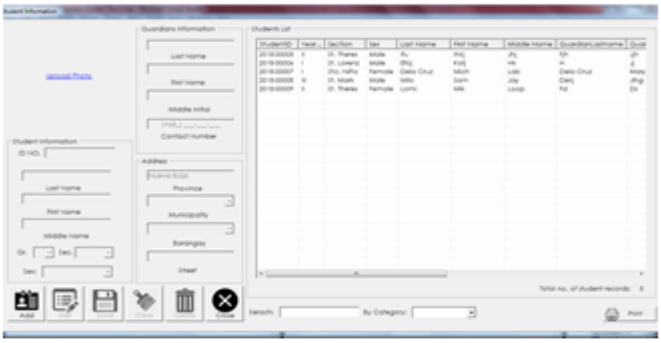

Fig. 5a. Figure 5a shows the Student Information Form as one of the user interfaces in the developed cashless payment system. This form is used to enter the student information essential for the transactions required for system.

Fig. 5b. Fig ure 5b is another example of a user interface in the cashless payment system. The form is use for the transaction

3.1.4 Testing

The testing stage of the incremental model was an important stage to undertake in order to ensure that the plan developed in the first stage of the model was properly executed. Also, this stage ensures that the requirements identified and the ex-

pected intended output were achieved to bring efficient and effective solution to the problems encountered in relation to cash-based payment transactions. The researchers during this stage of the incremental model have undergone series of testing which include negative testing approach to find errors and bugs which might possibly affect the over-all performance of the system. Interface testing and functionality testing techniques were also used to see how was the performance of the system in terms of its user interface and over-all functionality. Other approaches were also used to check and continuously improve the system.

3.2 The assessment on the technical qualities based from ISO 9126 standards with the following criteria:

Table 2 below presents the results of the assessment made by the respondents to the system based from the users' point-of-view regarding technical qualities.

Criteria	Mean	Verbal Interpretation
Functionality	3.65	Very Good
Reliability	3.78	Very Good
Usability	3.70	Very Good
Efficiency	3.70	Very Good
Maintainability	3.73	Very Good
Portability	3.64	Very Good
Overall Result	3.70	Very Good

The cashless payment system based from the assessment made by the respondents got an overall rating of a "Very Good" ($\mu = 3.70$) which indicates that the respondents viewed the system as a tool that met the quality standards for software development in the perspective of users. Particularly, the different areas such as functionality ($\mu = 3.65$), reliability ($\mu = 3.78$), usability ($\mu = 3.70$), efficiency ($\mu = 3.70$), maintainability ($\mu = 3.73$), and portability ($\mu = 3.64$) got a rating of "Very Good". The users perceived the system to be functional because it has all the necessary features commonly peformed in the conventional setting of a manual or cash-based payment system. While it is true that the processes involved in the manual system was still present in the automated system, the respondents thought that the developed system was more functional, more reliability, and more efficient in terms of handling the day-to-day transactions of a canteen, particularly, in the payment process because of the existence of a repository of data or a database integrated in the system. Also, the system was viewed as maintainable because of its capacity to maintain the records of the users. Having a system with the capacity to maintain its records properly is an indicator of a good software for it can be further enhanced and developed in the future. Most quality software has this feature because it shows how flexible a system can be amidst the changing and fast-pacing environment of today's generation. Lastly, it was viewed portable for it has the capacity to be transferred easily from one area to another. It may be viewed physically or electronically. In terms of its physical aspect, the system can be easily placed or transferred from one area to another without thinking of the impact of changing its location. On the other hand, in terms of being electronically portable, the data can be easily transferred from one area to another for future purposes. Overall the developed system passed the assessment made by the respondents of this study.

4 CONCLUSIONS

In general, this study entitled the design and development of a cashless payment system with an automatic identification and data collection technology achieved its purpose of describing the processes undertaken to develop the project and assessed its technical qualities by the respondents. It followed the incremental model of software development with the following stages: planning, requirements analysis, design and development, and testing. The researchers were able to discuss and described the essential activities necessary for the design and development of the project. The assessment was based from the ISO 9126 software standards with the following software criteria: funtionality, reliability, usability, efficiency, maintainability, and portability. The respondents of this study assessed the system based on its technical qualities. This study found out the following: (1) the cashless payment may be developed following the incremental model of software development, and (2) the respondents viewed the system as an acceptable alternative tool to cash-based payment transactions in a school canteen.

5 RECOMMENDATIONS

Based from the conclusions made, the following recommendations were drawn: (1) the need to conduct more studies employing the incremental model of software development is essential to contribute to the body of knowledge so that the model will be further refined and enhanced (2) the assessment on the technical quality of the software may be assigned to other group of experts to see how they view the project in different perspectives, (3) larger of number of respondents may be involved to further analyze their views and perspectives, (4) an empirical analysis on the assessment for the cash-based and cashless payment systems may be conducted to know their differences supported by empiral evidences, and (5) replication of the same study and concept may be made so that more similar studies can be developed to serve as basis for future studies and references.

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