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Applying the Waterfall Model to Develop the Student Learning Record and Assessment System for the Remote Public Primary School in Thailand

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Abstract

This system development aims to help the teacher in the remote public primary school in Thailand to reduce the amount of time spending on the complex paper work. The student learning record and assessment system is designed and developed according to the Waterfall model to complete all the requirements and processes systematically. User Management System, School Information System, Student Registration System, Staff Management System, Curriculum Structure System, Home Room Teacher/Subject Teacher System, Academic System, Student Behavior Assessment System, Student Grading System, and Report System are ten main functions designed for the program. The developed system has been tested in one sample school in remote area to confirm the correctness of all functions. The results show that all functions of the system work correctly while the satisfaction score for the system performance and utilization is 3.87 and which for the interface design and ease of use is 3.83 out of 5 rating scale.

Keywords— Application Development, Learning Record System, Learning Assessment System, Waterfall Model

I. INTRODUCTION

The real problem of most remote primary school in Thailand is the limited budget. Since this type of school is mainly public school with small number of students and the budget of the school is granted from the government according to the number of students. This results in limited approved budget. Also, the limited budget is only capable of limited number of teachers and staffs allowed.

Although, they are responsible for very few students, the number of responsibilities and paper works are not fewer than the larger school. Every process, works, and paper works are needed to be completed in the same requirement and regulation. Therefore, the school needs the teachers to cover the staff duties along with their main responsibilities, teaching and looking after the students. Moreover, these remote primary public school often located in the small community away from the city. They have limited access to the facilities provided by the government.

One solution to aid the teachers in these school to reduce the paper work time and be able to have more time spent on the most important job of all teachers, teaching, is to have the system that can record and complete the assessment effectively. Since, the student learning record and assessment due to the government regulation is very manually detailed and time consuming. Therefore, the objective of this work is to develop the Student Learning Record and Assessment System to help the teachers save time.

The Waterfall model is applied for systematically development of the application

from start to finish. The system is also designed as a web-based application for future scalable development.

II. THAILAND PUBLIC PRIMARY SCHOOL

Fig. 1 shows the administration chart of Thailand public primary school. Nearly 30,000 public primary schools are under 183 Primary Education Service Area Offices which report directly to the Office of Basic Education Commission [1]. Around half of all schools are the small size school which have not more than 120 students actively [2]. Moreover, almost all of the small size schools are located in the remote or rural area away from the city. Fundamentally, the students in these schools are not able to access the city provided infrastructure, service, and facilities.

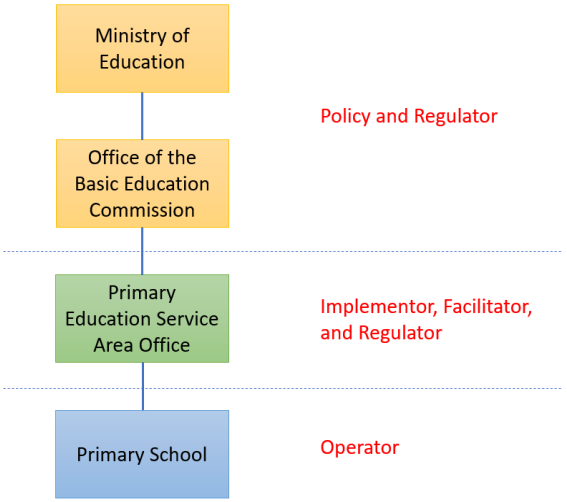

Figure 1. *Administration Chart*

The data from [2] shows that the number of teacher and student ratio in the small size school is approximately 1 out of 10. Therefore, if the school has about 50 active students, the school would be assigned only 5 teachers systematically. This results from the budget allowed. The school budget is granted mainly according to the number of active students. So, the small size school is allowed to have a very limited number of teacher staff while the works needed to be covered are just the same as the larger size school.

Although, every public primary school in Thailand is responsible for 4 main duties, Academic, Budget, Personnel, and General Administration., the most important jobs of all primary teachers everywhere are teaching and looking after the students. For the large size school, all of the other jobs could be done by the hired staffs. Because of the budget allowed, the large size school would have more money to spent in hiring more staffs. On the other hand, the medium and small size school would have to spent all of the budget paying for the teacher salary. Fortunately, the medium size schools, they can be distributed to many teachers to help contribute time to cover all the works because they already have enough teachers. But for the small size school, all of these has to be done the same way with a very limited number of teachers.

One of the time-consuming works has to be done by the teacher is recording each student learning record, attendant, behavior, health and hygiene. This is a paper work the teachers required to manually complete it every day. Moreover, at the end of each semester and each academic year, all of the collected data has to be summarized reporting to the upper-level administration. This record is considerably very detailed and complex manual paper work.

III.STUDENT LEARNING AND ASSESSMENT RECORD

The Ministry of Education of Thailand has set the framework for the basic education [3]. This framework aims to direct the way to develop the students to be the quality learners. By having 4 major components of learning assessment, 8 Subject Areas of Content, Reading / Writing / Analytical Thinking, Desired Characteristic, and Learner Development Activities as shown in Fig 2, the students would be hoped to developed to be the good and intelligent people, having quality lives, and having competitive capabilities internationally. Therefore, the school has to report all of these aspects of the student performance to the upper-level administration.

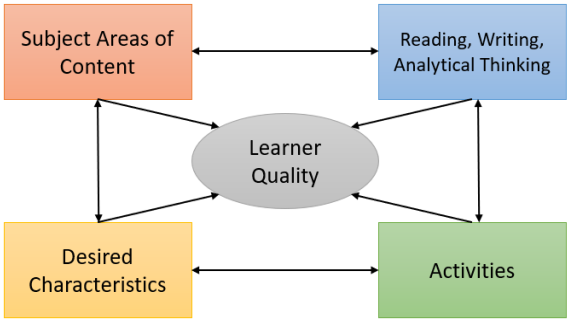

Figure 2. *Assessment Component Relation Diagram*

According to [4], the Basic Education Core Curriculum has prescribed the eight learning areas as follows.

1. Thai Language
2. Mathematics
3. Science
4. Social Studies, Religion, and Culture
5. Health and Physical Education
6. Art
7. Occupations and Technology
8. Foreign Language

For each learning area, the learning standards serve as the goals in developing learner's quality. Teachers are needed to use multiple tools to evaluate the learner qualities including observation and monitoring not only from the school paper work but also the behavior during on and off the class. The Reading, Writing, and Analytical Thinking are the key competencies set for the student in the primary level. They are valued to direct the learner to be able to comprehend the study in the higher level in the future. The assessment for these key competencies should be done continuously throughout the semester and academic year.

The desired characteristics are as follow.

1. Love of nation, religious, and the monarchy
2. Honesty and integrity
3. Self-discipline
4. Avidity for learning
5. Applying principles of Sufficiency Economy Philosophy, in one's way of life
6. Dedication and commitment to work
7. Cherishing Thai nationalism
8. Public-mindedness

These characteristics are said to be the desired characteristics for the society. Then, the student would live together with others peacefully as a quality Thai and global citizen. The leaner development activities are divided into 3 categories, the guiding activity, social and commonwealth activity, and boy/girl scout and club activity. The assessment of these activities is mainly on the participation and outcomes of the activities.

The Learning Assessment for Graduation Criteria of the primary school in Thailand for each student are as follow [4].

1. Complete basic course and supplementary course and/or activities in accord with the learning time structure as prescribed in the Basic Education Core Curriculum.
2. Meet the criteria prescribed by the respective educational institution for the assessment outcome.
3. Meet the criteria prescribed by the respective educational institution for the assessment outcomes regarding reading, analytical thinking, and writing.
4. Meet the criteria prescribed by the respective educational institutions for assessment outcomes regarding desired characteristics.
5. Meet the criteria set by the respective educational institutions for the assessment outcome and participate in the learner development activities.

For the learning outcome judgement, the teachers must base their judgement individual development of the learners. Teachers is required to regularly and continuously collect the learner data in all aspects for each semester, as well as provide remedial teaching to enable learners to fulfill their highest potential. The learning outcome judgements for the primary education level are as follow [4].

1. Must have an attendance record of not less than 80% of the total learning time requirement.
2. Must be assessed on all indicators and pass the criteria prescribed by the educational institution.
3. Must be judged on the learning outcomes of each course.

4. Must be evaluated and pass all the criteria prescribed by the educational institutions regarding reading, analytical thinking, and writing, desired characteristics, and learner development activities.

Having 80% attendance for one academic year means the student would have enough time to be in all the planned development process. The school-set benchmarks are according to the school context. They should be set to reflect the suitability of the students, the school, and the local environment. The course grading is done according to the central regulation but could be adjusted according to the school context.

IV. WATERFALL MODEL

The Waterfall Model is a sequential development model which is flowing downward, like a waterfall, through separate phrases as shown in Fig 3. Winston Royce [5] was the first to introduce the model although the term "waterfall" was not used at the time. Waterfall model was said to be the first Software Development Life Cycle (SDLC) Model in software engineering. The outcome of one phase acts as the input of the next phase sequentially. The Waterfall model is suitable when [6]

- the developing program is small.
- the requirements are stable and clear.
- the environment is stable.
- the used development tools are stable.
- the resources are available and well trained.

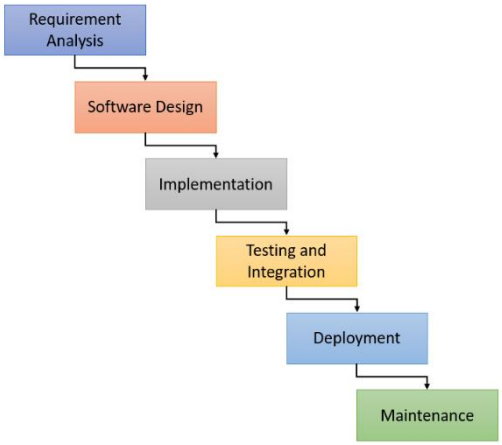

Figure 3. *Waterfall Model*

In other word, the Waterfall model works well with the small, stable, clear environment. It is not favorable to the large-scale system development or often change requirement. Since the user is the small public primary school in the remote area, the system is relatively small. All the environment and requirements are quite clear and rigid according to the regulation of the school reporting system. Therefore, this project meets all the suitable conditions suggested for using the Waterfall Model.

Table 1. *Activities of each Waterfall Model phase*

	Phase	**Activities**
1	Requirement Analysis	Gather all the possible requirement Complete requirement specification document
2	System Design	Study the requirement specification Prepare the system design to specify hardware and system requirement and to define the overall system architecture
3	Implementation	Develop the small unit programs Test the unit function
4	Testing and Integration	Integrate all units into a system Test the entire system for faults and failures
5	Deployment	Deploy in the user environment or release to real world
6	Maintenance	Fix the issue come up in the user environment If necessary, release update patch or enhance the program to a better version

V. 5. DESIGN OF THE SYSTEM

5.1 From Requirements to Design

After study the problems and difficulties of the teacher work along with the government regulation and the school environment, the major system requirement was summarized as shown in Table 2. The requirements were majorly gathered from the teachers in one of the public primary schools in the remote area through the deep interview and on-site observation process. The school was selected to be the sample school due 3 major reasons. Firstly, the school condition and environment matched all the criteria except for one, the school has a fine internet connection. Secondly, the principal of the school is a technology acceptance person who is willing to use the program to reduce the complexity of paper work for the staffs. And lastly, there is a couple of young teachers who is familiar with the internet and computer program in daily use. All of these helped make this prototype project run more smoothly.

Table 2. The gathered requirement of the system

Functions	Requirement Description
Teacher	All teacher data can be managed. Teacher can be assigned to the class. Teacher can be assigned to the subject. One teacher can be assigned in multiple classes and multiple subjects.
Student	All student data can be managed. Student can be assigned to the class. Student in the same class might have different optional subject. The whole class can be moved up to the next academic year.
Curriculum	All curriculum data can be managed. Curriculum can have multiple subject groups and subjects.
Subject	All subject data can be managed. Each subject can have different grading and scoring criteria.
Others	All school data can be managed. Some student in some year might have the o-net score in some subject. The report can be generated according to the government regulation.
Hardware	System should tolerate the unstable internet connection. Teacher can access the system throughout the school area via Wi-Fi connection.

From all the requirements acquired, the project was design to be a web-based program installed in the server along with the database. The standalone network model was chosen. The program with 2 level of users, Admin (Administrator) and Teacher, has 10 main functions as follows.

1. User Management System
2. School Information System
3. Student Registration System
4. Staff Management System
5. Curriculum Structure System
6. Home Room Teacher/Subject Teacher System
7. Academic System
8. Student Behavior Assessment System
9. Student Grading System
10. Report System

5.2 Hardware

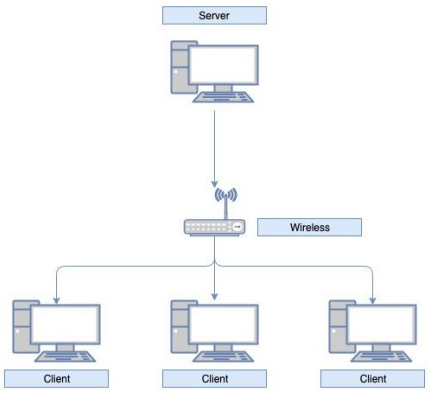

Figure 4*. Network Structure Diagram*

The first idea of the deployed hardware was installing the program on the internet cloud in order to limit the on-site maintenance difficulty. Although, the school that the project was run-tested has a fine internet connection, most of the school in the same type might not have so. Therefore, for this project, the standalone server model has been selected to be implemented as shown in Fig 4. The remote access software has also been set up in the server for the future maintenance purpose. This allows every teacher in the school to be able to access the server all the time within the school area. Moreover, most of the teachers live in the school official residence within the school area which also have the connection from the school available all the time.

5.3 Software Functions Design

Table 3 shows the function and authorization rights for each sub system of the whole program. The detail shown in Table 3 can be picturized into the sitemap as shown in Fig 6. The entity relation diagram is also shown in Fig 5.

Table 3. *Function and Authorization of each Sub system*

Sub systems	**Functions**	**Rights**
User Management	Create Admin account Change Admin information Change Admin password	Admin
School Information	Change school information	Admin
Student Registration	Create new student Change student information	Admin/ Teacher
Staff Management	Create Teacher account Change Teacher information Change Teacher password	Admin Admin/ Teacher
Curriculum Structure	Create/change curriculum Create/change subject type Create/change subject Create/change optional subject Add subject into curriculum Remove subject from curriculum	Admin
Home Room /Subject Teacher	Create/change classroom Add Teacher to classroom Remove Teacher from classroom Add student to classroom Remove student from classroom Add/remove opened subject Add/remove optional subject Add Teacher to opened subject	Admin
Academic	Create/change scoring criteria Move up the student to new class Put in/change student o-net score	Teacher
Student Behavior Assessment	Put in/change student score in subject/optional subject Check/change attendance	Teacher
Student Grading	Grading the student Document grading information	Teacher
Report	Report Document 1-9	Admin

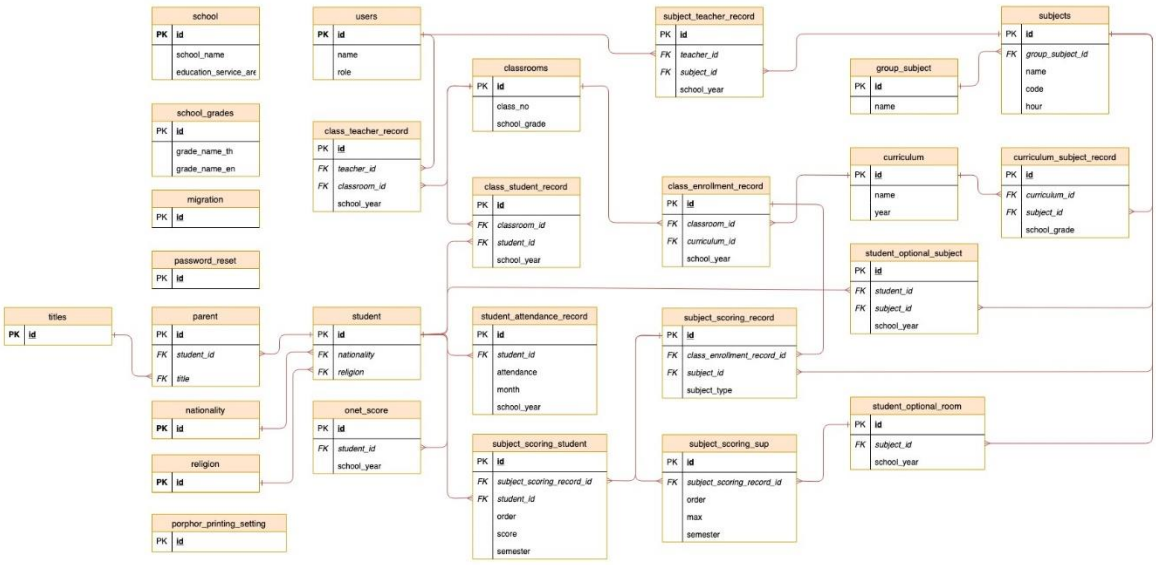

Figure 5. *Entity Relation Diagram*

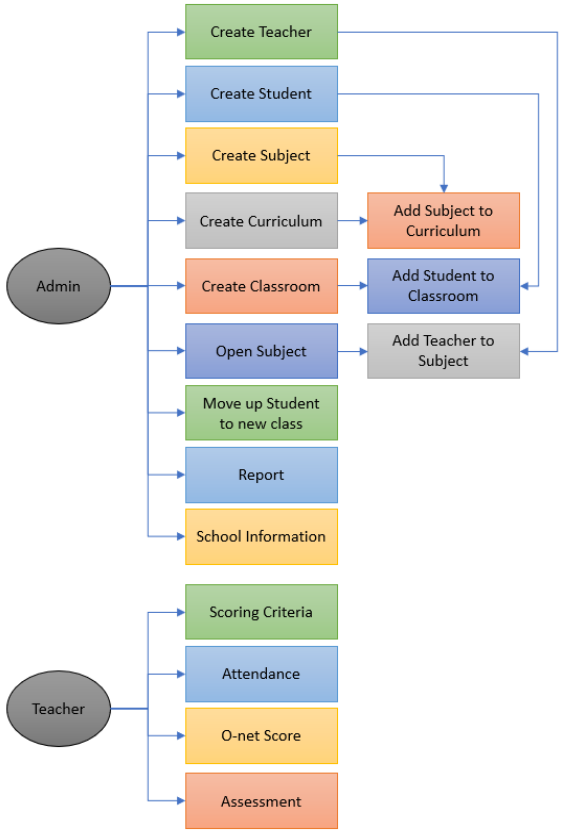

Figure 6. *Sitemap*

VI. TESTING AND RESULTS

After the development completion, the program has been brought to test at the sample school. The whole school has 6 teachers totally including the principal and everyone has participated in testing the program. The sample school meets all the targeted condition to be a small remote public primary school. The program has been tested run along with the traditional paper work process for one semester. The data of the first semester has been filled in the system prior to the test in the second semester in order to cover all the process of one whole academic year. The program test has been run in the second semester parallel along with the conventional process to compare the end result for correctness.

Table 4. *The satisfaction Assessment of the program*

	Mean
Utilization and Performance	
Correctness of function	3.33
Correctness of calculation and report	4.00
Complexity of the program	3.00
Working time spent	4.00
Paperwork reduction	5.00
Average	**3.87**
Interface and Ease of Use	
Interface Design	4.00
Readability and Appearance	3.66
Average	**3.83**

At the end of the second semester, after all of the academic year paper work has been completed, the program shows the exact same

result as the conventional way without any faults. This confirms that the program has been working correctly as it supposed to do so. At the end of the project, the satisfaction assessment has been done through the questionnaire. Four questions on system performance and utilization and two question on the interface design and ease of use have been asked for assessment from all of the participated users.

Table 4 shows the result of the satisfaction assessment from the tested user. The question asked the satisfaction score in 5 rating scale which can be interpreted as follows.

5 means very satisfied
4 means satisfied
3 means fair
2 means dissatisfied
1 means very dissatisfied

The results shows that the Utilization and Performance of the program has the average satisfaction score of 3.87 and the Interface and Ease of Use of the program has the average satisfaction score of 3.83 in 5 rating scale.

VII. CONCLUSION AND RECOMMENDATIONS

The Student Learning Record and Assessment System for the small remote public primary school of Thailand has been succeed. The Waterfall model used in applying for the development process has been suitable for the scale and environment of this project. The program has been working correctly and well smoothly during the test run. It eventually helps the teachers in reducing the time spent on the complex paper work as this project aims to be.

However, there are couple of issues needed to be looking into the detail. Firstly, the satisfaction score received from the assessment was 3.87 and 3.83 out of 5. These number can be interpreted as the user are almost satisfied with the program. Looking deeper in the detail, the performance aspects of the program are in the satisfied and more satisfied zone but the complexity of the program is just in the fair level. Moreover, the appearance and interface design of the program are also almost satisfied. These could mean that the users still feel that the program is not yet user friendly enough and the still hard to understand and learn to use. This could mean that the program is still needed to be improved before releasing to the other schools. The easier to understand manual might need to be created in order to help the users in using the program.

Secondly, in order to reduce the maintenance issue in the future, the system should be developed into the cloud system. This would help the other school to access the system right away without any on-site hardware deployment. Less budget would be used up for the project as well. In order to achieve these objectives, two problems are need to be clarified and solved.

The program would be needed to scale up to handle more transaction from much more account logging in at the same time as well as the securities. This is definitely achievable. However, another issue is the school capability. In the real world, not every school have enough resources available. Some schools still have poor internet connection, some might have not enough budget, and some might not have a knowledgeable staff for this system. There is still hope that in a few years from now, this could change. And if so, the teacher would have more time focusing on taking good care of the student rather than spending much time on paper work.

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