Developing a Human Resource Information System through Hybrid Software Engineering Model

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ABSTRACT

Company CDE manually handles payroll, employee information, and employee leaves. This led to disorganized documents and an overall unproductive working environment for employees. Payroll generation was tedious and susceptible to errors, employees had difficulties accessing their personal information and submitting requests because the entire process was manual. This took a lot of their time and affected their productivity.

The researchers used a Hybrid Software Engineering model in developing the human resource information system (HRIS). In the planning phase, they used the Waterfall Model, and the Agile Methodology during the development phase. To address the needs of the client, the researchers created an HRIS that will handle employee leaves, attendance, information, loan, and payroll.

The Hybrid Model was effective in developing the HRIS. Through the Waterfall Model, the needs of the client were documented as the requirements and a system prototype was made. Doing so was helpful in the Agile Methodology development phase because the use of the Waterfall Model aided in making sure that all client needs were addressed. The Agile Methodology helped in ensuring the good quality of the system through the constant meetings required. Overall, the client was pleased with the resulting system.

KEYWORDS
Payroll, Attendance, HRIS, System

1 INTRODUCTION

The client company was founded in 2006, and is currently based in Nueva Ecija. They have 50 employees, and they serve 30-35 clients every month. The company's issue was that they were using a manual way of handling their payroll, storing employee information, and handling employee leaves. Because of this, the Payroll Master would have errors and miscalculations in calculating each employee's monthly payroll, and took a long time to process them. As a result, employees received their salary later than expected. The concerns of the employees with the civil status are that the process is manual and inefficient. Because of this, employees need to have to alot time to make these kinds of requests, along with submitting leaves. When the employees want to file their leaves, they have to go and line up to the human resources (HR) department to submit their forms. Thus, it will take them more time to submit their requests and get a response.

Given that they have issues in employee information and payroll creation, providing an HRIS would be a solution for the company. The HRIS is a software that will help HR employees and the Payroll Master to record and update employee records, and manage payroll functions [1].

Software Engineering
According to Sommerville [3], Software Engineering is software development that provides solution while sticking with the budget. It focuses on forming theories, and adapting methods and tools during software development. Moreover, it is also an engineering discipline that is responsible for phases and elements of software development. Software Engineering is in demand for businesses because they need developers to develop systems that are reliable, and cost-efficient. Some fundamentals of Software Engineering are: (1) systems must be developed in a manageable and understandable process, (2) dependability and performance is a must for all kinds of software, (3) researchers must have a clear understanding and management of the specifications and requirements, and (4) implement software reuse to avoid building functions from scratch which will cost more time.

The 4+1 Model
According to Kruchten [2], the 4+1 Model was developed to recognize customers' doubts, and it consists of: logical view, process view, physical view, and development view. The logical view represents the system's object method when an object-oriented method is involved, and provides details on functional requirements to its end users. An example of this is an entity-relationship diagram. The process view tackles the system's concurrency and synchronization, and shows the nonfunctional requirements such as performance, availability, system. The physical view represents the "system's mapping of the software to the hardware and its distribution phases.." The development view depicts the system's "static organization in its development environment."

The Waterfall Model
According to Sommerville [3], the Waterfall Model, also known as a software life cycle, is a software process model used to represent the fundamental operations of activities in specification, development, validation, and evolution. These phases are separated by processes which are requirements specification, software design, implementation, or testing. The

main phases of the Waterfall Model are: (1) requirements definition, (2) system and software design, (3) implementation and unit testing, (4) integration and system testing, and (5) operation and maintenance. This method requires tedious planning and data collecting because it is a plan-driven method. Requirements analysis and elicitation tackles confirming and defining the system's factors such as services, constraints, and goals with the end-users, and the information retrieved will be used for system specification. System and software design requires identifying and outlining fundamental abstractions and their relationships to establish an overall architecture. Implementation and unit testing handles verifying and checking the functions if they meet the specifications, and is done when the system's design is compiled in a set of programs or program units. Integration and system testing integrates and tests the complete system to guarantee that each function in the system meets the requirements, and delivered right after. The operation and maintenance process requires fixes and patches on any errors or bugs that were not found during the early development, and makes improvements in the implementation of each unit of the system while enhancing its services and discovering new requirements.

As defined in [4], some of the advantages of the Waterfall Model are: (1) it is simple and easy to use for development, (2) it is manageable due to its rigid design since phases requires their own deliverables and process reviews, (3) each phase does not overlap with each other because they are done one at a time, and (4) it is suitable for small projects when requirements and specifications are clearly understood. However, this method also has its own drawbacks. Some of the disadvantages are: (1) changes are hard to implement after development has started (2) working software is only produced in the later phases, (3) it is not suitable for large systems because of their complexities, and (4) because its rigidity, it is not suitable for projects that need changes during development.

Agile Methodology
According to Sommerville [3], the Agile Methodology relies on incremental progress for specification, development, and delivery. It is most usable for projects that require changes during its development process. This method requires frequent communication between developers and client, and delivers the software through incrementals. Moreover, this method requires developers to assign tasks by cards and these cards contain the description of how the function should work. Moreover, developers must undergo sprint meetings to present the progress of the system and discuss about the newly included functions. Scrum meetings were conducted to keep track of the incremental development of the system done by developers, and the frequency of these meetings depends on the scrum master. Furthermore, the developers can make frequent changes in the organization of the development due to the method's flexibility. On the other hand, this methodology may have its own disadvantages for the researchers. Since the developments are incremental, the developers need to present deliverables regularly. Because of the software's quick developments, it is not effective to produce documentations since there were new versions produced. Due to this, the development does not require intensive documentation and

planning which will make it hard for developers to turn over the project in case they need to.

Hybrid Model
Figure 1 shows the combination of Waterfall Model and Agile Methodology. It emphasizes on the requirements and definition, system and software design, and implementation and unit testing. In the implementation and unit testing lies the Agile Methodology which are; define, develop, release, and evaluate. The researchers were given around 5 to 7 months, to develop the system. The research team consists of 3 members. The researchers came up with a model that can combine the advantages of both Agile Methodology and Waterfall Model which is the Hybrid Model. The Hybrid Model that was used by the researchers consists of combining some elements of the Waterfall Model and the Agile Methodology. The Waterfall Model was used mainly for producing the documents and other deliverables. The Waterfall Model allowed the researchers to define: user requirements, non-functional requirements, company details, overview of the system, and specifications. This fixes the problem of not producing adequate document in Agile Methodology. Agile Methodology was used for system development. This required the researchers to assign tasks boards which consists of tasks description and deadlines, and conduct sprint and scrum meetings to review the progress of the development. This method also includes incremental development of the software. Agile also provided flexibility that allowed the development to adapt to changes.
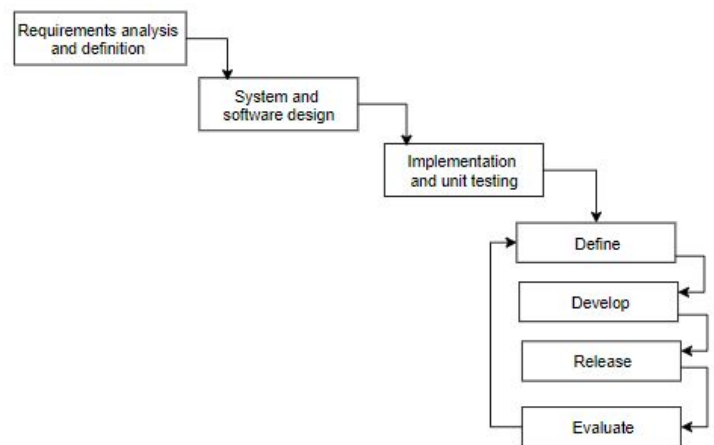

Figure 1. *Waterfall Model + Agile Methodology Implementation Diagram*

2   RESEARCH OBJECTIVES

Given the case above, the researchers have identified the following objectives:

1. Describe the Hybrid Model for SE.

2. Identify the process issues of Company CDE's current payroll process.

3. Design and Implement an HRIS that addresses the identified issues.

3   METHODOLOGY
3.1 Research Design

The research design that was used for this research is exploratory design. As defined by [5], this method allows the researchers to discuss insights and details with the client to familiarize themselves with the concerns and issues with the company's situation. Through this design, they were able to get the big picture of the situation. This allowed the researchers to generate new ideas on how to solve and address the company's concerns.

3.2 Data-Gathering Procedure

The researchers first started by getting information about the company and figuring out the deficiencies in the company's day to day process. In the requirements gathering and analysis phase, the researchers gathered data through interviews with the client to know the requirements, specifically the user requirements and functional requirements which served as guide for the system functionalities. The researchers used content analysis to process and analyze the data that was gathered from the meetings and interviews. These interviews were conducted virtually through emails, virtual meetings, and third party applications such as Teamviewer, and evaluation sheets were handed out during the sprint meetings.

To further understand the problems of the client, the researchers held 5 meetings with a representative from the company. During the initial meeting, the client representative, which is the employee of the company, disclosed the background of the company, their current business processes, and their problems. The succeeding meetings covered further analysis of the problems and requirements of the company regarding the system. Through the meetings, the researchers and the company discussed the kinds of data to serve as input for the system. Moreover, the researchers clarified the dependencies of the functions in the system. Meetings were held also for the purpose of answering questions and clarifications from the researchers.

Prototyping

The Agile Methodology was also applied in the programming and implementing stage, and was mainly used in the development of the prototype. The researchers organized the tasks cards for each sprint. Scrums were also implemented to keep track of the system's progress. Each sprint lasted for at least 30 working days, and scrum meetings were conducted at least once a week every wednesday. Scrum meetings were used to discuss the matters and issues of the system with the scrum master, and figure out ways to solve them. Client evaluations were held every end of sprint whereby the researchers presents the prototype and incremental developments with the client.

3.2 Evaluation

According to Sommerville [3], criteria for evaluating the prototypes consists of:

1. Dependability and Security
   The system should be trustworthy for the client to use, and must not have major system failures that may have heavy impact on the client.
2. Efficiency
   The system should not waste resources such as memory or processors cycles, and must be fast responsiveness and processing time.
3. Acceptability
   The system should be easy enough for the client to use without referring to a manual frequently.
4. Usability
   The system must provide ease of use for the users.

The feedback of the client were collected and organized by the criteria mentioned, and were measured through a likert scale. The likert scale will serve as overall evaluation of the client to the system. The mean scores of the likert scale will be rated from: 1.00 - 2.00 being the low, 2.01 - 3.00 as below average, 3.01 - 4.00 as average, and 4.01 - 5.00 as above average.

4   RESULTS AND DISCUSSION

Table 1 shows the issues of the company, and the answers from the interviews to determine the issues that are needed to be addressed by the system.

Table 1. Content Analysis

| Issues	Answers
The company has issues in calculating a payroll.	• It usually takes 5-6 hours to calculate the payroll. • The payroll master computes manually which is prone to errors.
The employees have problems in filing requests, and leaves.	• The employees have to file their leaves through paper forms and submit it to the office. • The employees will have to wait for the response by lining up in the HR office.
The company has no clear organization of measuring deductions and income according to attendance.	• The employees who work on weekends are considered as working in normal days. • There are no penalties imposed for those who only work on weekdays.
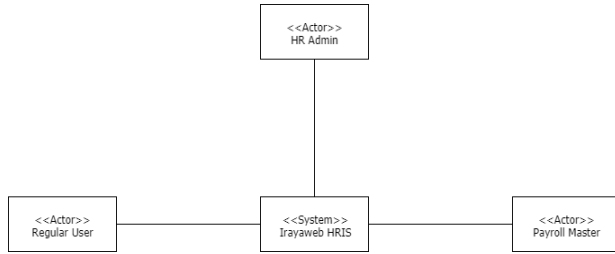
**Figure 3.** *Software Context Diagram*

Figure 3 shows the system and the external entities interact with it, particularly the users. From the interviews, the researchers were able to figure out who are the main users of the system. The users of the system are the: (1) the Payroll Master who will be handling the payroll-related processes in the system, (2) the HR Admin who will be facilitating employee accounts, attendance, and requests, and (3) the Regular User which is a regular employee who will keeping track with the changes in his account, salary, and attendance.

Implementation of Waterfall Model and Agile Methodology

The implementation of Waterfall Model was conducted during the system analysis and design phase of the system. In this stage, the researchers have to conduct interviews and company assessments to figure out the user requirements, and the specifications that the system should have. It also tackles on the specifications and the entities concerned with the system. The Waterfall Model helped the researchers define the requirements, make analysis of the company, and construct a design of the system. In this phase, the researchers have to gather data to formulate system analysis that they will use to design the system. During this stage, the researchers will have to figure out the main users of the system, and the attributes that they that relate with each other.

Figure 4. *Entity Relationship Diagram*

Figure 4 illustrates the relationships of the tables that were used in the database. Each contains the attributes of entities involved in the system. One of the main entities in the diagram is the employee. An employee
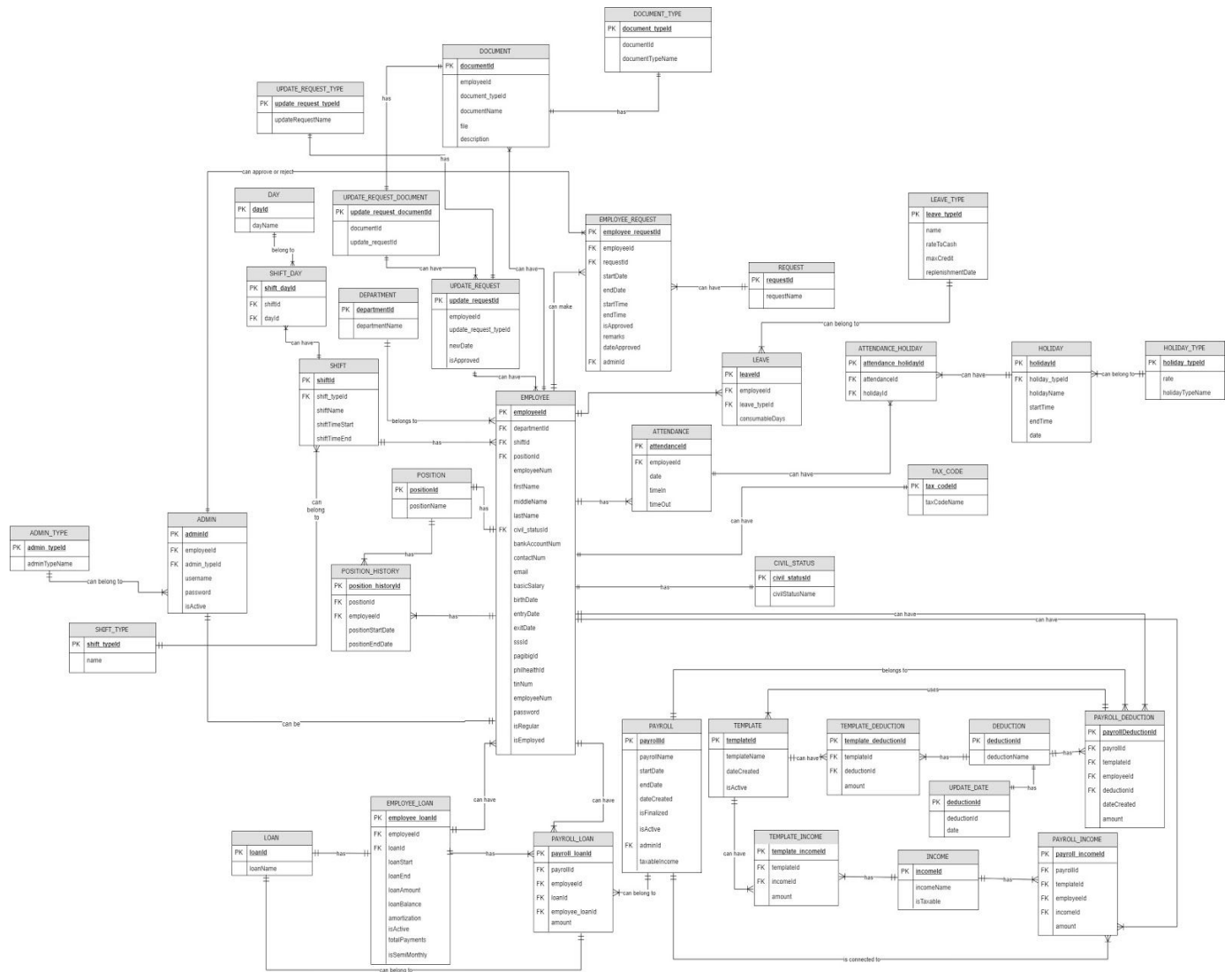
can make request for the admin which can be a leave, attendance, or overtime. The HR Admin will then view the request and choose whether to approve or reject it. The employee will then receive the reply whether his request has been accepted or denied. An employee can also be an HR Admin who can make alterations in the user accounts and add records for departments, attendance, position, civil status, shifts, leave types, and holidays. An employee can also be a payroll master. A payroll master is the person who computes incomes, deductions, and payroll in the system. He also have the authority to change with SSS Table, PAGIBIG Table, and WithholdingTax Table. When the payroll master is done computing the payroll for the employees, the employees will receive a digital payslip that summarizes their salary for a month, and a ledger that will help them keep track of their income and deductions.

The Agile Methodology was implemented in the development phase where the system was being implemented. During this phase, the researchers will start assigning the tasks, and develop the functionalities of the system. This phase also includes implementation and testing of the system. This phase also require the researchers to define the tasks and requirements, develop the functions, release incremental developments, and evaluate the activities of every sprint.

Table 2 shows the comments and suggestions that the client made during sprint meetings. The client made suggestions for the user interface regarding the forms and selections in sprint 1. The client commented that there was an improvement on the interface but it needs more testing to ensure that all functions are working in sprint 2. The client suggested that the researchers would make amount and amortization fields changeable, alter input, and make loans deletable.Because of the client's comments, the researchers added functions that allows the users to delete loans, amount in fields changeable, make rigorous test on the prototype, choose many selections with checkboxes, and select time and date with time and date pickers.

Table 2. Sprint Evaluation

| Sprint	Client Suggestions and Insights
1	- There was a problem in the format for employee creation form. The client suggested that we should move the fields horizontally. - Change the shift days input into checkboxes in creation of shift - Use timepicker for time input
2	- Good improvement on the user interface - However, there are some functionalities that are needed to be fixed so that they are working correctly.
3	- Add predictive text box in employee input for loan creation and change it ID to employee number or employee name - Make the amount and amortization changeable - Make loans deletable - Good improvement on the system.
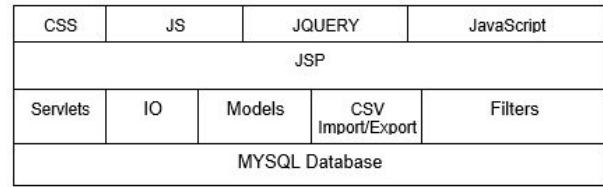
Figure 2. *Architectural Diagram*

Figure 2 shows the architectural diagram whereby the researchers made use of applications, and third party libraries such as: CSS, JS, Jquery, CSV Import and Export, and Javascript for the user interface. They mainly used JSP to construct the user interface of the system. For the back-end of the system, servlets, IO, models (serve as beans), and filters were used to support the infrastructure. Servlets were used to connect the websites and functionalities. IOs were used to contain the methods needed to support the website. The models served as objects for every entities that are included in the system. MySQL Database was used to contain the data needed the processes of the system.

After the implementation and designing the system, the researchers were able to develop a system that satisfies the requirements of the client. The functionalities of the system are able to accomodate the needs of; having employee accounts for employee records, easier payroll computations, and managing employees.

With the help of the HRIS, the payroll master can compute payroll for employees with minimized miscalculations. Since the system will provide forms to have a customized template, the payroll master can fill the template, save the template, and include the employees in the payroll scheme. This will automatically compute and generate the payroll for the employees. This approach helps the company avoid loss and provide better service for its employees by paying them right and on-time.

In the HR admin portal, the HR admin can create employee records. This also allows the HR admin to update employee records and change the status of employment. Unlike the employee portal which grants only a number of fields for updating employee records, the HR admin can update all employee information in the HR admin portal. To update the civil status and number of dependents, the HR admin will receive update requests from the employee. Upon approval, the HR admin will input the requested change. Additionally, the HR admin can view employee attendance and employee requests.

The HR admin can also approve or reject employee requests. Employee requests include attendance, leave and overtime requests. The system will be managing employee information and requests in an automated environment, which means employees no longer need to directly go the HR office to file requests and inquire about the approval of their requests. The HR admin can also sort and prioritize the requests by search filters according to specific category.

The HRIS manages employee attendance tracking by importing records from an external DTR system. When employees want

to monitor their attendance, they no longer need to go to the human resources office to request for a physical copy of their attendance. Rather, through the employee portal, employees can easily view their attendance records and filter the dates with a datepicker.

In the employee portal, regular users can view and edit their profile, request for leave, overtime, and attendance approval, view their balance for each type of leave, view their attendance records, view details related to their active loans, and view their payslip and employee ledger.

Table 3 shows the results of the sprint evaluations given by the client. The ease of use criteria tackles how easy for the user to use the system. The pleasant appearance criteria tackles the external aspect or the front-end of the system. The reliable criteria tackles on the failure rate of the functionalities. The secure criteria examines how protected the system from vulnerabilities. The efficiency criteria points out the conformity of the system to its users. From the table, the score for: (1) ease of use is above average, (2) appearance is above average, (3) reliability is average, (4) security is average, (5) efficiency is average, (6) complete function is average, (7) complete features is average, and (8) readiness for deployment is average. Based of the given data, the mean score of the client evaluation is 4.28 which falls under above average. Because of this, the client is satisfied with the production and performance of the researchers during the development.

Table 3. Client Evaluation

Category	Mean Score
Usability	4.33
Appearance	4.33
Reliability	3.67
Security	4.00
Efficiency	3.33
Functionalities	3.33
Features	3.33
Deployment Readiness	3.67

5   CONCLUSION

The Hybrid Model was able to provide mobility to the development of the system without missing out on the producing deliverables needed by the client and the research. Through the Hybrid Model, the researchers were able to address the needs of the research and the system. With the Hybrid Model, the researchers were able to make changes and produce deliverables that contain the documentation of the system. The researchers were able to make major changes in the design and implementation of the system through the development. Moreover, the researchers were able to satisfy the requirements of the company because the Hybrid Model allowed the researchers to stay connected and inform the client on the progress of the system. Because of this they were able to keep track of what is going on with the development. Thus, the researchers were able to develop an HRIS system through the Hybrid Software Engineering model.

The researchers were able to gather data from interviews and analysis that helped the identify the main problems and issues of the company with the client. These issues points out mainly on the payroll process and the organization of the processes in the company which were; filing of leaves and requests, organizing employees, and keeping track of the employee activities. Moreover, the client was able to realize these new issues that affects the performance of the company.

The researchers were able to implement an HRIS system that solves their issues and problems regarding the payroll, requests, and employee organization. Moreover, not only did it give mobility for the users to keep track of their payroll, and other records, but the company is able to work efficiently with their day-to-day process without having too many issues in their internal affairs.

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