CHAPTER 2
LITERATURE REVIEW

2.1. Review of Past Research

Previous research is an attempt by researchers to find comparisons and then to find new inspiration for further research. In addition, previous studies help research to position research and show the originality of the research.

1. Research conducted by Firamon Syakti, Hutrianto (2022), with the title *"Development of E-Learning System Using Codeigniter Framework and Waterfall Model on MTs Negeri 1 Musi Banyuasin".* Based on the 1945 Law, article 31 paragraph one states that every citizen has the right to be taught. So that every educational institution is obliged to provide services under any conditions, including in emergencies such as Covid-19. One solution to overcome this problem is to develop all learning media such as e-learning. With the existence of learning media through e-learning, it is hoped that the learning process will continue to run normally. The problem as mentioned certainly occurs in MTs. Negeri Bumiayu is one of the schools in Musi Banyuasin Regency. To achieve the goal to overcome these problems, namely developing e-learning using the Codeigniter framework and Prototyope model. The results of the development show that the e-learning produced has features that can overcome the learning process well as evidenced by e-learning features such as materials and tasks in the learning process.

2. Research conducted by Alfath Yauma, Iskandar Fitri, Sari Ningsih (2020), with the title *"Learning Management System (LMS) pada E-Learning Menggunakan Metode Agile dan Waterfall berbasis Website".* The education information delivery system at the MA Alwutsqo school is still being carried out as usual even though the pandemic outbreak in Indonesia is still not over. Because the school does not have a system to support distance learning. By implementing health protocols and teaching and learning time events, students often do not get an understanding of the material presented by the teacher. Learning Management System (LMS) is one of the systems needed by the school. Therefore, the authors designed a website-based E-learning application

system with the aim of helping the learning and teaching process at MA Alwutsqo Depok City. The design of this information system uses Waterfalls and system development is carried out using the Agile method. The result is that students can download the material that has been delivered and can do the exercises given by the teacher without recommendations by time and space

3. Research conducted by Riska Amelia, Gufron (2018), with the title *"E-Learning Design Based On Learning Management System In Web Programming Course"*. The number of students who have difficulty in understanding web programming courses resulting in low student learning outcomes. It is necessary for an innovation to develop and enhance the capabilities of students, especially in web programming courses. The purpose of this research is to design and produce e-learning-based learning management system (LMS) on the subjects of web programming. Research methods used in this study is the method Waterfall. The results of this research have produced e-learning based lms that can be utilized by students to enhance learning motivation of college students. Based on the results of performance tests on gtmetric.com obtained the data that the page access speed score is 94% and fully loaded time is 3.1 s

4. Research conducted by M R Fachrizal, F Ramadhan (2018), with the title *"Design of Web-Based E-Learning Application"*. This research aims to design a Web-based E-Learning Application at Rumah Belajar LCC-Line. The methods used in designing applications use Waterfall methods, starting from listening to user needs, building mock-ups of applications, and testing mock-up of applications to users. Systems analysis method uses Object Oriented Analysis and Design (OOAD), and Unified Modelling Language (UML) as a system design tool. The results of this research is a web-based e-learning application design that consists of interaction design between users, data design, and interface design. This E-Learning Application Design can be used to develop and implement E-Learning Applications. With this Web-Based E-Learning Applications can help the process of distance learning so that the learning process becomes more effective and efficient.

5. Research conducted by Elvis Pawan, Rosiyati, Thamrin, Patmawati Hasan, Sariyati Bei, Paulisen Matu (2021), with the title *"Using Waterfall Method to Design Information System of SPMI STIMIK Sepuluh Nopember Jayapura"*. Conventional filing of SPMI documents is a problem experienced by STIMIK Sepuluh Nopember Jayapura, archiving in this way can result in documents being lost or scattered, in addition to causing difficulties in finding documents during internal and external audits. This study aims to assist institutions in improving their filing systems, so that SPMI data or documents can be stored properly and easily obtained when needed. In designing the information system SPMI STIMIK Sepuluh Nopember Jayapura, using the Waterfall method and data modeling using data flow diagrams, while in system testing using the blackbox method and user acceptance test. This research produces an SPMI information system that can be used to archive all types of documents owned by the internal quality assurance agency Based on table 2, as many as 86% of the answers of respondents who answered were very correct (SB), as many as 12% of respondents who answered correctly (B) and 2% answered doubtful or neutral.

6. Research conducted by Rizqi Putri Nourma Budiarti, A N Fathin, Sulistiyani (2022), with the title *"Website-Based Student Achievement Book Using the Waterfall Method"*. The method used in this research is the Waterfall method approach in the manufacture of information systems with several stages, including problem identification, system requirements analysis, system design, system creation, and system testing, and also system analysis. In making the system, PHP and MySQL are used with the CodeIgniter framework. In system testing, the author uses two methods of black-box testing and white-box system testing. While the results of the analysis of the system in terms of testing the quality ofservice users, namely by using usability testing. The results of this study are a website-based student achievement book as an online learning achievement record book that can function well, both systemically and from the user's side of the application and greatly assists the needs of the Al-Badar TPA during the pandemic. The results obtained from the usability testing analysis are 90%, so it can conclude that the system is feasible and easy to use. So, a website-based student achievement book as book's achievement record

online can function properly and greatly help the needs of the TPA Al-Badar during the pandemic.

2.2 Theoretical Basis

2.2.1 Design

Understanding design according to Nadeak (2016: 54), Design is the first step in the product or system engineering development phase. Design is the process of applying various techniques and principles aimed at defining a device, a process or a system in detail that allows for physical realization. Meanwhile, according to Maimunah (2017: 38), design is that every design must meet the needs of its users and can function properly, functions arise as a result of human needs in an effort to maintain and develop life and life in this universe.

According to Nur et al. (2018:5) also mentions that design is a process to create and design a new system. The main purpose of design is to meet the needs of system users to achieve this goal, a systems analyst must be able to achieve the following goals:

1. System design must be useful, easy to understand and later easy to use this means that data must be easy to obtain, methods must be easy to apply and information must be easy to generate and easy to understand
2. The system design must support the main goals of the company or agency
3. System planning must be effective and efficient to be able to support decisions that will be taken by the leadership, including other tasks that are not carried out with computers (Cahyono, 2015).

2.2.2 System

In a company or agency there must be a system that regulates the performance that exists within the company or agency. According to Sutarman in the journal (Okta Veza & Ropianto, 2017). The system is a collection of elements that are interconnected and interact in a unit to carry

out a process of achieving a main goal. According to Kusrini in the journal (Okta Veza & Ropianto, 2017). that the system is a set of interrelated or integrated elements intended to achieve a goal. From the two opinions above, it can be concluded that the system is a unity of interconnected parts that are in an area. These relationships are integrated with each other to achieve something desired.

1. System Characteristics

   A system has the characteristics contained in a set of elements that must be understood in identifying the manufacture of the system. The characteristics of the system (Hutahaean, 2015:3) are as follows:

   a. Component

      The system consists of a number of components that interact and work together to form a single unit. System components can be sub-systems or parts of the system

   b. Boundary

      The area that limits the system to other systems or to the external environment is called the system boundary. This system boundary allows the system to be seen as a single unit and also shows the scope of the system.

   c. Environment

      Anything that is outside the boundaries of the system and affects the system is called the external environment of the system. The external environment that is beneficial must be maintained and the harmful must be controlled so as not to interfere with the continuity of the system.

   d. Interface

      Media liaison is needed to drain resources from sub-systems to other sub-systems called the liaison system.

   e. Input

      The energy entered into the system is called the system input (input) which can be in the form of maintenance and signal input. This treatment functions so that the system can operate and the input signal is energy that is processed to produce output.

f. Output

The result of the energy that has been processed and classified into useful output is called the system output (output). Information is an example of system output

g. System processor

To process input into output requires a processor called a system processor

h. System goal

The system must have a goal or goal that really determines the input needed by the system and the resulting output

2.2.3 Information

Information is a very basic thing that is needed by an activity in making a decision so that mistakes do not occur. Information can also be interpreted as data that has been processed into a form that is more useful and more meaningful to the recipient of the information. According to Anggraeni and Irviani (2017:13) information is a collection of data or facts that are organized or processed in a certain way so that they have meaning for the recipient. Sutabri in Trimahardhika and Sutinah (2017: 250), Information is data that has been processed, classified and interpreted and used for the decision-making process.

1. Information Grouping

Information can be grouped into three parts, namely:

a. Strategic Information. This information is used to make long-term decisions, which include external information, planning expansion plans, and so on.

b. Tactical Information. This information is needed to make mid-term decisions, such as sales trend information that can be used to develop sales plans.

c. Technical Information. This information is needed for daily operational purposes, such as stock inventory information, sales returns, and daily cash reports

2. Information Characteristics
    a. Relevant, information must have a high meaning so that it does not cause doubts for those who use it and can be used appropriately to make decisions
    b. Reliable, an information must have high reliability, information that is used as a decision-making tool is a real event in the company's activities
    c. Complete, the information must have a detailed and clear explanation of every aspect of the event being measured
    d. On time, every information must be in an updated condition not in an obsolete form, so it is important to use it for decision making
    e. Understandable, information presented in a clear form will make it easier for people to interpret it

3. Information Quality
    a. Accurate

       Information must be free from error and not biased or misleading. Accurate also means that the information must clearly reflect the intent. Information must be accurate because from the source of information to the recipient of the information there may be a lot of interference (noise) that can change or damage the information
    b. Timelines

       Information that reaches the recipient should not be late. Information that is outdated will have no value anymore, because information is the basis for decision making. If decision-making is late, it can be fatal for the organization
    c. Relevance

       This information has benefits for the user. The relevance of the information for each person is different. Conveying information about the causes of damage to production machines to the company accountant is certainly less relevant. It will be more relevant if it is addressed to the company's technical experts

2.2.4 Website

Website is an address (URL) that serves as a place to store data and information based on certain topics. The web is a hypertext system, consisting of millions of text pages linked by hyperlinks (Sanjaya & Hesinto, 2018). Website is a collection of components consisting of text, images, animated sound so that it is an interesting information medium and is in great demand to be used as a medium for sharing information. Website technology processes data into information by identifying, collecting, processing and providing it can be accessed together (Widagdo et al., 2018).

Website is often also called the Web, which can be interpreted as a collection of pages that display various kinds of text information, data, still and moving images, animation data, sound, video or a combination of all of them, both static and dynamic, which form a a series of interconnected buildings, each of which is linked by a network of pages or hyperlinks. Website is an internet facility that connects documents locally and remotely. Documents on the website are called web pages and links on the website allow users to move from one page to another (hypertext), both between pages stored on the same server or servers around the world. Pages are accessed and read through browsers such as Netscape Navigator, Internet Explorer, Mozilla Firefox, Google Chrome and other browser applications (Morina & Samsoni, 2020).

From some of the opinions above, it can be concluded that the website is a collection of pages that display various kinds of text information, data, still and moving images, animation data, sound, video or a combination of all of them, both static and dynamic, which form a a series of interrelated buildings, each of which is connected to a network of pages or hyperlinks that function as a place to store data and information based on a particular topic so as to allow users to move from one page to another, both between pages stored on the same server or servers around the world.

1. Types of Websites

Along with the rapid development of information technology, the website has also experienced significant development. In the grouping of web types, it is more directed based on the function, nature or style and the programming language used (Cahyodi & Arifin, 2017).

a. Types of webs based on its nature or style:
   1) *Dynamic website, is a website that provides content that changes all the time. The programming languages used include PHP, ASP, .NET, and utilize MySQL or MS SQL databases. For example, the website www.article-it.com, www.detik.com, www.kompas.com and others*
   2) *A static website is a website whose content is rarely changed. The programming language used is HTML and has not utilized the database. For example: organization's web profile, and others.*

b. Based on its function, the website is divided into:
   1) Personal website, a website that contains a person's personal information.
   2) Commercial website, a website owned by a business company.
   3) Government websites, websites owned by government agencies, education that aims to provide services to users.
   4) Non-Profit Organization website, owned by non-profit or business organizations.

c. In terms of the programming language used, the website is divided into:
   1) Server Side, is a website that uses a programming language that depends on the availability of the server. Such as PHP, ASP, .NET and so on. If there is no server, a website built using the above programming language will not function properly
   2) Client Side, is a website that requires a server to run it, just accessed through a browser only. For example, HTML

2. Website Functions

The function of the website is as follows: (Hernandhi et al., 2018)

a. Promotional media, as promotional media can be divided into main promotions, for example websites that function as search engines or online stores or as supporting main promotions, but websites can contain more complete information than offline promotional media such as newspapers or magazines.

b. Marketing Media In online stores or affiliate systems, the website is a fairly good marketing medium, because compared to stores as in the real world, to build an online store it requires relatively small capital, and can operate 24 hours even though the website owner is not in place, and is accessed Where have you been.

c. Media Information Portal websites and online radio or tv provide information that is global in nature because it can be accessed from anywhere as long as it is connected to the internet, so that it can reach a wider range than conventional information media.

d. Educational Media There are communities that build special websites containing information or articles full of scientific information, such as Wikipedia.

e. Media of Communication There are many websites that were built specifically for communication such as forums that can provide facilities for members to share information or help solve certain problems.

2.2.5 XAMPP

XAMPP is a software that functions to run PHP-based websites and uses MYSQL data processing on a local computer. XAMPP acts as a web server on the local computer. XAMPP can also be called a virtual cPanel server, which can help preview so that the website can be modified without having to be online or accessible to the internet (Fridayanthie & Mahdiati, 2016). XAMPP stands for X (four any operating system), Apache, MySQL, PHP, Perl. XAMPP is a tool that provides software packages in one package. The XAMPP package already includes Apache (web server),

MySQL (database), PHP (server-side scripting), Perl, FTP server, PhpMyAdmin (Prabowo & Syani, 2017).

XAMPP is a web server software that is useful in website development that is useful in website development in which a MySQL database server is available and can support PHP programming, XAMPP is free software, can be run on Windows, Linux or MacOS operating systems. XAMPP software can be obtained for free at http://www.apachefriends.org/en/xampp.html according to the operating system used (Nanda & Maharani, 2018).

From some of the opinions above, it can be concluded that XAMPP is a software that functions to run PHP-based websites and uses MYSQL data processing on a local computer". XAMPP acts as a web server on a local computer. XAMPP is a web server software that is useful in developing websites that are useful in website development in which a MySQL database server is available and can support PHP programming.

2.2.6 Hypertext Preprocessor (PHP)

PHP is a programming interpreter, which is the process of translating source code lines into machine code that the computer understands directly when the line of code is executed. PHP is referred to as Server-Side Programming, this is because the entire process is run on the server, not on the client. PHP is a language with open copyright or also known as Open Source, where users can develop PHP function code according to their needs (H. Hidayat et al., 2017).

PHP is a scripting language that is placed on a new server and then processed. Then the processing results are sent to the client's web browser. This programming language is specially designed to build dynamic web. This means that PHP programming can create a view based on recent requests, for example a page that displays a guest list. The page will always

change following the number of guest data that has filled out the guest book (Rubiati, 2018).

PHP is a programming language intended for creating web applications. Judging from the processing, PHP is classified as server side based. That is, the processing is done on the server. This is in contrast to languages like JavaScript, where the processing is done on the client side. PHP is often said to be a language for creating dynamic web applications. The definition of dynamic here is that it is possible to display data stored in the database. Thus, the web page will adjust to the contents of the database (Hasanah et al., 2019).

From some of the opinions above, it can be concluded that PHP is a programming language that is intended to create web applications, the process of translating source code lines into machine code that the computer understands directly when the line of code is executed. PHP is an x language. This means that PHP programming can create a view based on recent requests, for example a page that displays a guest list.

2.2.7 MySQL

MySQL is a database that initially only runs on Unix and Linux systems. Over time and the number of enthusiasts who use this database, MySQL released a version that can be installed on almost all platforms, including Windows. The license of MySQL is freeware. We can download and use it without having to pay for it. Although we sell products that include MySQL software, we do not infringe copyright. Maybe those of us who are new to MySQL will be confused by the two words "SQL" and "MySQL". The question that might arise is, what is SQL, and how is it different from MySQL? SQL is an abbreviation of the word "Structured Query Language". SQL is a structured query language that is attached to a particular database or SMBD, while MySQL is the database. In other words, MySQL is the SMBD and SQL is the command or language inherent in the SMBD (Jafar et al., 2018).

MySQL is one of the DBMS (Database Management System) applications that are widely used by web application programmers. In an unrelation database system, all information is stored in one broad field, which is sometimes very difficult and tedious to access the data in it. But MySQL is a relational database system, so it can group information into related tables or groups of information. Each table contains separate fields, which represent each bit of information. MySQL uses indexes to speed up the search process for certain rows of information. MySQL requires at least one index on each table. Usually, will use a primary key or unique identifier to help track data (Lutfi, 2017).

MySQL is a DBMS software (or database server) that can manage databases very quickly, can accommodate very large amounts of data, can be accessed by many users (multi-user), and can perform a process synchronously or simultaneously (multi-threaded). (Christian et al., 2018).

From some of the opinions above it can be concluded that MySQL is a relational database system, so it can group information into tables or groups of related information so that it can be processed.

2.2.8 Framework Codeigniter

Web Application Framework (WAF), or often abbreviated as web framework, is a collection of code in the form of libraries and tools that are combined in such a way as to become a framework to facilitate and speed up the process of developing web applications (Budi Raharjo, 2015). :2). Codeigniter is a PHP application development framework based on a structured architecture. Codeigniter aims to provide the necessary tools such as helpers and libraries to implement commonly performed tasks. Thus, project development becomes easier and faster. And developers don't have to write again from scratch. (Arrhioui et al., 2017).

CodeIgniter has many features (facilities) that help PHP developers to be able to create web applications easily and quickly. Compared to other

PHP web frameworks, it must be admitted that CodeIgniter has a simpler and more flexible (not rigid) design. CodeIgniter allows developers to use the framework partially or completely. CodeIgniter is a toolkit intended for people who want to build web applications in the PHP programming language. Some of the advantages offered by CodeIgniter are as follows:

1. CodeIgniter is a free and open-source framework
2. CodeIgniter has a small size compared to other frameworks. After the installation process, the CodeIgniter framework is only about 2MB in size (without documentation or if the user guide directory is deleted). The CodeIgniter documentation is about 6MB
3. Applications made using CodeIgniter can run fast
4. CodeIgniter uses the Model-View-Controller (MVC) design pattern so that a single file doesn't contain too much code. This makes the code easier to read, understand and maintain later on
5. CodeIgniter can be extended as needed. CodeIgniter is well documented. Information about the class libraries and functions provided by CodeIgniter can be obtained through the documentation included in the distribution package

2.2.9 Black Box Testing

Black box testing also known as Behavioral Testing is a software testing method in which the internal structure, design, and implementation of a part being tested is unknown to the user. In black box testing, functionality and non-functionality are tested, although usually only functionality is tested. This software testing method is called a black box because the software program being tested in the eyes of the examiner or tester is like a black box, what is in it is unknown (Lestari, 2019).

Black Box testing is the testing of an application that discusses the external side of a software application, where from appearance to input action, the Black Box testing strategy has several methods including Equivalence Partitioning, Boundary Value Analysis. Equivalence Partitioning discusses testing in the input validation aspect seen from the

Valid Class, Observation of the input content and input accuracy. Boundary Value Analysis discusses Black Box testing in terms of the overall menu and module, so that the error side can be identified (T. Hidayat & Muttaqin, 2018). Black-Box Testing is a test that focuses on the functional specifications of the software, the tester can define a collection of input conditions and perform tests on the program's functional specifications (T. Hidayat & Putri, 2019).

From some of the opinions above, it can be concluded that black box testing, also known as Behavioral Testing, is a software testing method in which the internal structure, design, and implementation of a part being tested is unknown to the user. The Black Box testing strategy has several methods, including Equivalence Partitioning, Boundary Value Analysis.

2.2.10 UML (Unified Modeling Language)

Unified Modeling Language (UML) is a modeling language that has become the software industry standard for visualizing, designing, and documenting software systems. UML (Unified Modeling Language) is a visual modeling method as a means to design and or create object-oriented software. Because UML is a visual language for object-oriented language modeling, all elements and diagrams are based on the object-oriented paradigm. UML is one of the tools/models for designing object-oriented software development (Lesmana, 2017).

UML is a standard language for defining requirements, making analysis & design and describing architecture in object-oriented programming (Josi, 2017). UML is a system development technique that uses a graphical language as a tool for documenting and performing specifications on the system (Julianti et al., 2019).

From some of the opinions above, it can be concluded that UML (Unified Modeling Language) is a visual modeling method as a means to design and or create object-oriented software on the system.

1. UML Element

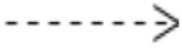
UML has a number of graphical elements that can be combined as follows:

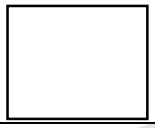
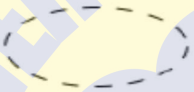
a. Use Case Diagram

Use case diagram (use case) is a model for the behavior of the information system to be made. Use case describes an interaction between one or more actors and the information system that will be created. Roughly speaking, use cases are used to find out what functions are in an information system and who has the right to use those functions. The naming requirement in the use case is that the name is defined as simply as possible and can be understood. There are two main things in use cases, namely defining what is called an actor and use case (Irsyad, 2018). Here are the symbols of the use case diagram:

Table 2.1 Use Case Diagram Symbols

(Source: Irsyad, 2018)

Symbol	Description
	Specifies the set of roles that the user plays when interacting with the use case.
	A relationship in which changes that occur in an independent element will affect elements that depend on elements that are not independent.
	A relationship in which a child object (descendent) shares the behavior and data structure of the object that is above the parent object (ancestor).
	Specify that source use case explicitly.

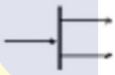
	Specifies that the target use case extends the behavior of the source use case at a given point
	What connects one object to another?
	Specifies a package that features a limited system
	A description of the sequence of actions performed by the system that produces a measurable result for an actor.
	Interaction of rules - rules and other elements that work together to provide behavior that is greater than the sum and its elements (synergy).
	Physical elements that exist when the application is run and represent a computing resource

b. Activity Diagram

Activity diagram is a diagram that is able to explain procedurally the process flow of a system. In this diagram it is possible to evaluate the possibility of more than one path being formed and running simultaneously. The depiction of the activity diagram starts from the initial node to end at the end node. It can be noted that the initial node in an activity diagram is allowed more than one. This is done to accommodate if the system being modeled has more than one input (Ayu, 2017). Here are the symbols of the activity diagram:

Table 2.2 Activity Diagram Symbols

(Source: Ayu, 2017)

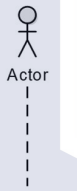
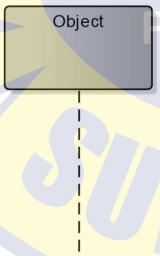
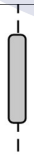
Symbol	Description
	Describes the start of an activity running on the system
	Describe the activities performed on the system
	Describes the condition of an activity that is true / false.
	Describing the division of grouping based on separate tasks and functions.
	Describing the end of an activity running on the system
	The Fork symbol indicates a parallel branching of the activity
	The Join symbol indicates a merging of activities
	Miracle Activities, there is no input and no output and is used at the start point.
	Black Hole Activities, there are inputs and no outputs

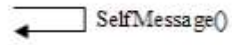
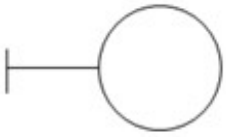
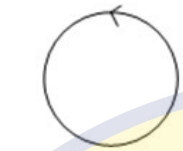
c. Sequence Diagram

Sequence diagram is a diagram that describes the dynamic collaboration between objects with one another. This collaboration is indicated by the interaction between objects in and around the system in the form of messages or sequential instructions. Sequence diagrams are generally used to describe a scenario or sequence of steps carried out by both actors and systems which are a response to an event to get results or outputs (M. K. Hidayat & Ningrum, 2017). Here are the symbols from the sequence diagram:

Table 2.3 Sequence Diagram Symbols

(Source: M. K. Hidayat & Ningrum, 2017)

Symbol	Description
	Used to describe the user / users.
	Indicates the existence of an object with respect to time. That is, objects are created or removed during a period of time the diagram is displayed, then the lifeline stops or starts at the appropriate point.
	Entity objects, interacting interfaces.
	Specifications of communication between objects that contain information about the activities that occur.

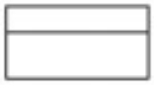
	An object that has an operation on itself.
	Used to describe a form.
	Used to connect boundaries with tables.
	Used to describe the relationship of activities to be carried out.

d. Class Diagram

Class Diagram is a specification that when instantiated will produce an object and is the core of object-oriented development and design. Class describes the state of a system, as well as offering services to manipulate the state. Class Diagrams also describe the structure and description of Classes, Packages and objects as well as their relationships with each other such as inheritance, association and others (Revelation, 2020). Here are the symbols of the class diagram:

Table 2.4 Class Diagram Symbols

(Source: Wahyudi, 2020)

Symbol	Description
	Class on the system structure.
	Attempts to avoid association with more than 2 Objects
	A relationship in which a child object (descendent) shares the behavior and data structure of the object that is above the parent object (ancestor).
	Description of the sequence of actions performed by the system that produces a measurable result for an actor
	Relations between classes with the meaning of generalization specialization (general special)
	A relationship in which changes that occur in an independent element will affect elements that depend on elements that are not independent.
	Relationships between classes with a general meaning, associations are usually accompanied by multiplicity
	A description of the sequence of actions performed by the system that produces a measurable result for an actor.

2. Steps to Use UML

The following are software development tips using UML (Lesmana, 2017):

a. Make a list of business processes from the highest level to define activities and processes that may arise
b. Map the use cases for each business process to define exactly the functionality that the system must provide. Then refine the use case diagram and complete it with requirements, constraints and other notes.
c. Make a deployment diagram roughly to define the physical architecture of the system.
d. Define other requirements (non-functional, security and so on) that must also be provided by the system.
e. Based on the use case diagram, start creating an activity diagram.
f. Define top-level objects (packages or domains) and create sequences and/or collaboration diagrams for each workflow. If a use case has the probability of being born normal and error, make one diagram for each flow.
g. Design a user interface model that provides an interface for users to execute use case scenarios.
h. Based on the existing models, create a class diagram. Each package or domain is broken down into a complete class hierarchy with its attributes and methods. It would be better if for each class a unit test was made to test the class's functionality and interactions with other classes.
i. After the class diagram is created, we can see the possibility of grouping classes into components. Therefore, make a component diagram at this stage. Also, define integration tests for each component to make sure it interacts properly.
j. Refine the deployment diagram that has been created. Detail the capabilities and requirements of software, operating systems, networks, and so on. Map components into nodes.
k. Start building the system. There are two approaches that can be used.

l. Use case approach, by assigning each use case to a specific development team to develop a complete unit code with tests.
m. Component approach, which assigns each component to a specific development team.
n. Perform module tests and integration tests and improvements to the model and its code. The model must always match the actual code.
o. Software ready for release.
p.

3. Purpose of Utilizing UML

The following main objectives in UML design are: (Gunawan & Prabowo, 2017)

a. Provide users (system analysis and design) with an expressive visual modeling language so they can develop and exchange meaningful data models.
b. Provides specialized mechanisms for extending core concepts.
c. Because it is a visual modeling language in its development process, UML is independent of certain programming languages.
d. Provides a formal basis for understanding modeling languages.
e. Drive market growth towards the use of object-oriented system design (OO) tools.
f. Supports higher level development concepts such as collaboration, frameworks, patterns and components of a system.
g. Have best practice integration