CHAPTER 2 SOFTWARE ENGINEERING METHOD

As we worked with the computer shown in Figure 2.1., we need a series of stages and certain methods in order to be able to produce aim for our objectives. Likewise in the software engineering, it needs certain stages to be productive. A successful software engineering needs not only strong computation capacity like algorithm, programming, and database but also strong, but also determination in meeting the goal, resolution method identification, development method, goal identification, resources requirement identification, and other factors. Such matters are related to software engineering methods.

Figure 2.1. Work With Computer

The content of this chapter not within the standard Software Engineering competence. However, the writer think it would be beneficial to know how to carry out software engineering and methods that normally being used. Several part of this chapter will likely difficult to understand, teacher may be needed to explain. The summary of the chapter is written at the end of the chapter.
(Source: Microsoft Office 2007 Clip Art)

OBJECTIVES

After you learn this chapter, you should be able:

- Understand the general characteristics of the process model in software engineering.
- Name several models of the software engineering.
- Know principles from the method waterfall, prototyping, and unified process
- Understood the stages in the software engineering.

2.1 SOFTWARE ENGINEERING PROCESS MODELS

There are many models were developed in Software Engineering to help the process of software development these models generally refer to the system development process model that was known as System Development Life Cycle (SDLC) as shown in Figure 2.2.

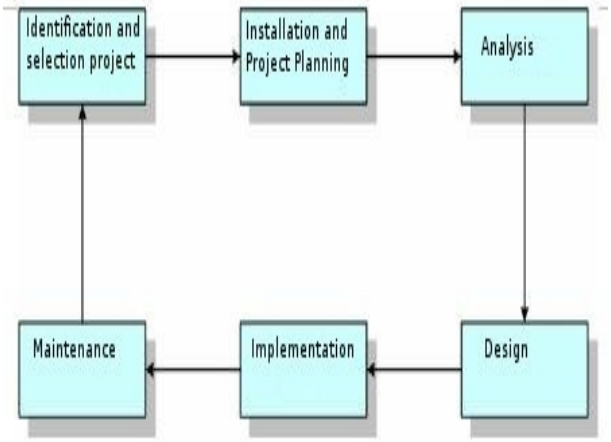


Figure 2.2. System Development Life Cycle (SDLC).

Each developed model has its own characteristics. However, in general, these models will fall into the following categories, namely:

- *Need for clear definition of the problem.* Main input in each software development model is in clear definition of the problem. The clearer the definition the better for problem solving processes. Thus, understanding the problem as explained in Chapter 1, is an important part of a software development model.

- *A structured development stages.* Although software development models may have different pattern, usually these models followed a general pattern of analysis – design – coding – testing - maintenance.

- *Stakeholder plays a very important role in the whole of the development stage.* Stakeholder in the software engineering may be the user, the owner, the developer, programmer and people who are involved in the software engineering.

- *Documentation is an important part of software development.* Each the stage in the model usually produces several articles, the diagram, the picture or other forms that must be documented and must not separated from the produced software.

- *The output of software development processes must have an economic value.* Although the value of software may be difficult to measure in terms of money. The effect of software usage give an added value to the organization. This could be in form of declining operating cost, efficient use of resources, increase in profit, improving organization image, etc.

There were many software development models, including The Waterfall Model, Joint Application Development (JAD), Information Engineering (IE), Rapid Application Development (the COUNCIL) including Prototyping, Unified Process (UP), Structural Analysis and Design (SAD) and Framework for the Application of System thinking (FAST). This book will discuss three (3) development models, namely, The Waterfall Model, Prototyping, and Unified Process (UP).

2.1.1.The Waterfall model

The life-cycle model is the main model and the foundation of many models. One of the models that is globally known in software engineering is The Waterfall Model. There are five (5) main stages in The Waterfall Model as shown in Figure 2.3. Known as waterfall since the process stage diagram resembled the stratified waterfall.
The brief stages in The Waterfall Model are as follows:

- Investigation stage is to determine whether a problem happening or is there an opportunity to develop an information system. In this stage the feasibility study must be carried out to determine whether the developed information system would be an appropriate solution.
- Analysis stage aim to look at the user and organization requirement as well as analyzing the available condition before the application of the new information system.
- Design stage determine the detail specification of the information system components, such as, human, hardware, software, network and data, and information products that in accordance with results of the analysis stage.
- Implementation stage is to get or to develop hardware and software (program coding), carried out testing, training and migration to the new system.

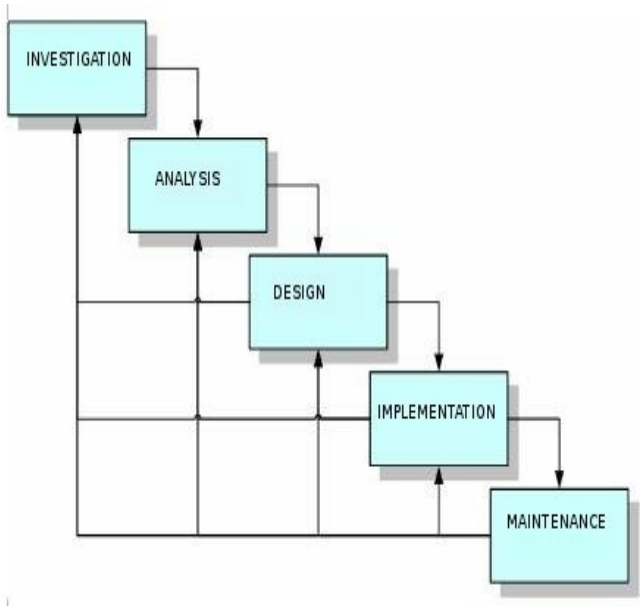


Figure 2.3. The Waterfall Model

- Maintenance stage carries out during the operation of the information system. In this stage, monitoring process, evaluation and improvement when being needed are carried out.

2.1.2 Prototyping model

Prototyping is one of software engineering approach that directly demonstrated how a software or software components will work in its environment before the actual construction stage is carried out (Howard, 1997).

Prototyping model could be classified to several types as shown Figure 2.4.

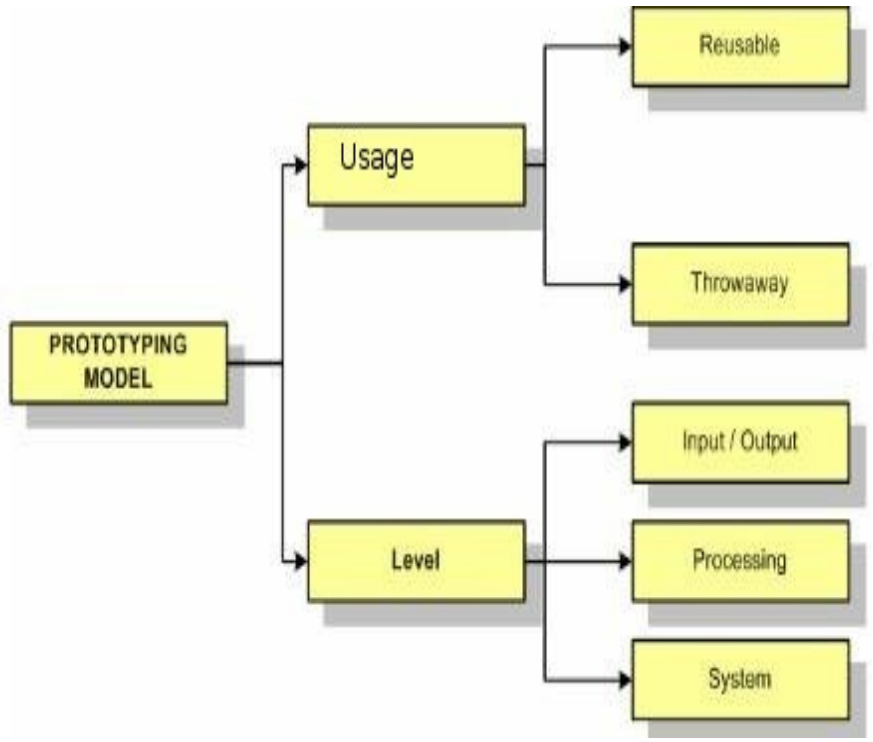


Figure 2.4. Classification of prototyping model (Harris, 2003)

- Reusable prototype: Prototype that will be transformed to the final product.
- Throwaway prototype: Prototype that will be thrown away as it completes its job.
- Input/output prototype: Prototype that was limited to the user interface.
- Processing prototype: Prototype that covered the maintenance file the

foundation and processes of the transaction.
- System prototype: Prototype that took the form of the complete model from software.

The stages in prototyping is normally an accelerate stages. The main strategy in prototyping is to build the easiest first and deliver to the user as soon as possible. Harris (2003) divided prototyping in six stages as being seen in the Figure 2.5.

The stages could be briefly explained as follows:

- Identification of the candidate prototyping. The candidate in this case covers user interface (menu, dialogue, input and output), main transaction file, and functions of basic processing.

- Engineering of prototype with help software like word processor, spreadsheet, database, graphics processor, and CASE (Computer-Aided System Engineering) software.

- Test prototype to confirm prototype able to undertake demonstration purposes.

- Prepare prototype USD (User's System Diagram) to identify parts of software that would be prototyped.

- Evaluate prototype with the user and carried out changes if being needed.

- Transform prototype into fully operated software and remove unnecessary codes, add needed programs, repeatedly improvement and test the software.

2.1.3 Unified Process and Unified Modeling Language

Unified Process (UP) or sometimes known as Unified Software Development Process (USDP) is the framework of development processes that use-case-driven, focus on software architecture, iterative and easy to grow (Alhir, 2005).

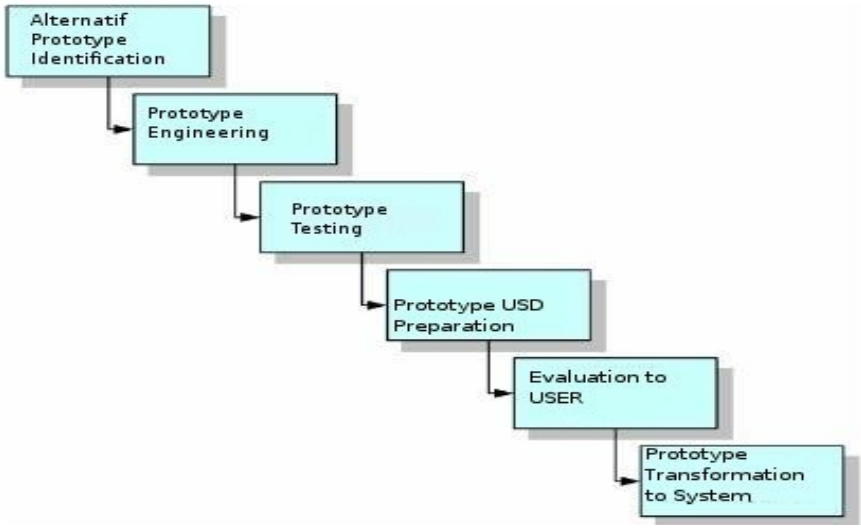


Figure 2.5. Prototyping model stages (Harris, 2003)

This framework is a relatively new in software development methodology. UP could be applied in various project scale, from small up to large scale.

The UP life-cycle generally will appear as shown in Figure 2.6. This chart is known as “hump chart”. Shown in the chart is the four (4) development stages, namely, inception, elaboration, construction and transition. Moreover, several activities must be carried out during the software development process, that is, business modeling, requirements, analysis and design, implementation, test. The stages and activities should be done in iterative manner (Ambler, 2005).

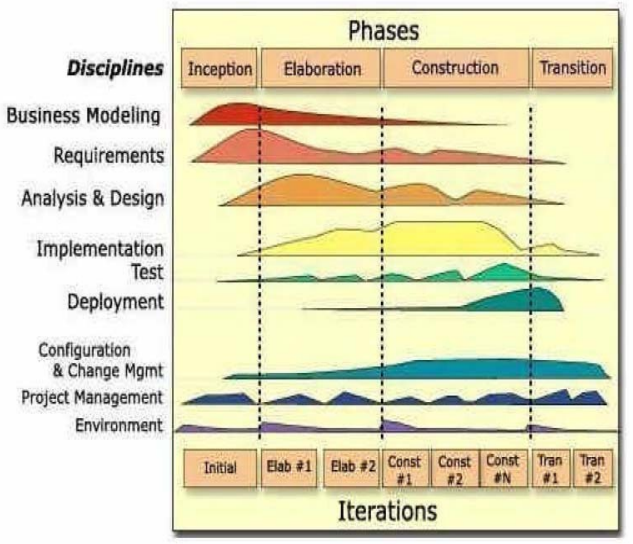


Figure 2.6. RUP Life Cycle (Ambler, 2005).

Short description of the four (4) stages in UP are as follows:

- Inception. This is the earliest stage that assess the carried out software project. It aims to get an agreement from stakeholders on its goal and project funding.

- Inception. This is the earliest stage that assess the carried out software project. It aims to get an agreement among the stakeholders on the objectives and project funding.

- Elaboration. The stage's objective is to get the picture on the general requirement, the condition and its main functions. This is important to know project risks, including software architecture risk, planning risk, and implementation risk. Despite its early stage, software engineering activities including business modeling, requirements, analysis and design are performed through iterative processes.

- Construction. This stage's objective is to construct the software to be used. The focus of this stage is to determine the level of priority in its requirement, its specification, in-depth analysis, the solution design to meet the requirement and the condition, coding and testing of the software. If possible, do beta testing to get early input from the user.

- Transition. The focus of this stage is to deliver the software to end user. Software would officially tested by both competent beta tester as well as the end users. Several activities, such as, data center migration, end user and staff training, should be performed in this stage.

In software development based on UP, **UML (Unified Modeling Language)** is normally used. Although UP requires the use of UML, ULM can be use in various methods including other field out side information system field. UML is a standard modeling language and a collection of modeling techniques to specify, to visualized, to construct as well as to document the work during software development (Fowler, 2004). UML was born from in merging of many object oriented graphics based modeling languages developed in the end of the 80's and early 90's.

UML is simply used to draw the sketch of the system. The developer used UML to send several software aspects through graphic notation. UML defined notation and the semantics. Notation is a collection special forms that has certain meaning to depict various diagrams of software and the semantics defined how these forms could be combined. There are several kind of diagrams that are provided in UML, including:

- Use-case diagram. This diagram is used to show the use-software interaction.

- Activity diagram. This diagram is used to show the behavior of the software.

- Class diagram. This diagram is used to show class, feature, and relations. In

this diagram, object oriented approach plays an important role.

- Sequence diagram. This diagram is used to show the interaction among objects with the emphasis on process sequence or events.
- State machine diagram. This diagram is used to draw how an event change an object in its lifetime.
- Component diagram. This diagram is used to show the structure and the component connection.

2.2. STAGES IN SOFTWARE ENGINEERING

As described, despite different approaches, models have some similarities in using the following pattern, namely, stage analysis – design – coding (construction) – testing – maintenance.

2.2.1. Analysis

System analysis is a problem solving technique that break a system into smaller components to examine or to evaluate the component performance and its interaction to reach its objectives.

The analysis may be a crucial part of software engineering processes. The next processes will be highly depend on the analysis results. The brief stages in software engineering analysis is shown in Figure 2,7.

One of the most important part that usually carried out in the analysis stage is the business process modeling. **Process modeling** is a model that focused in all processes in the system that transform data to information (Harris, 2003). Process modeling shows data flow that enter and exiting in a process. This model is usually depicted the Data of Flow Diagram (DFD). DFD describe man, process and procedure interaction in transforming data into information.

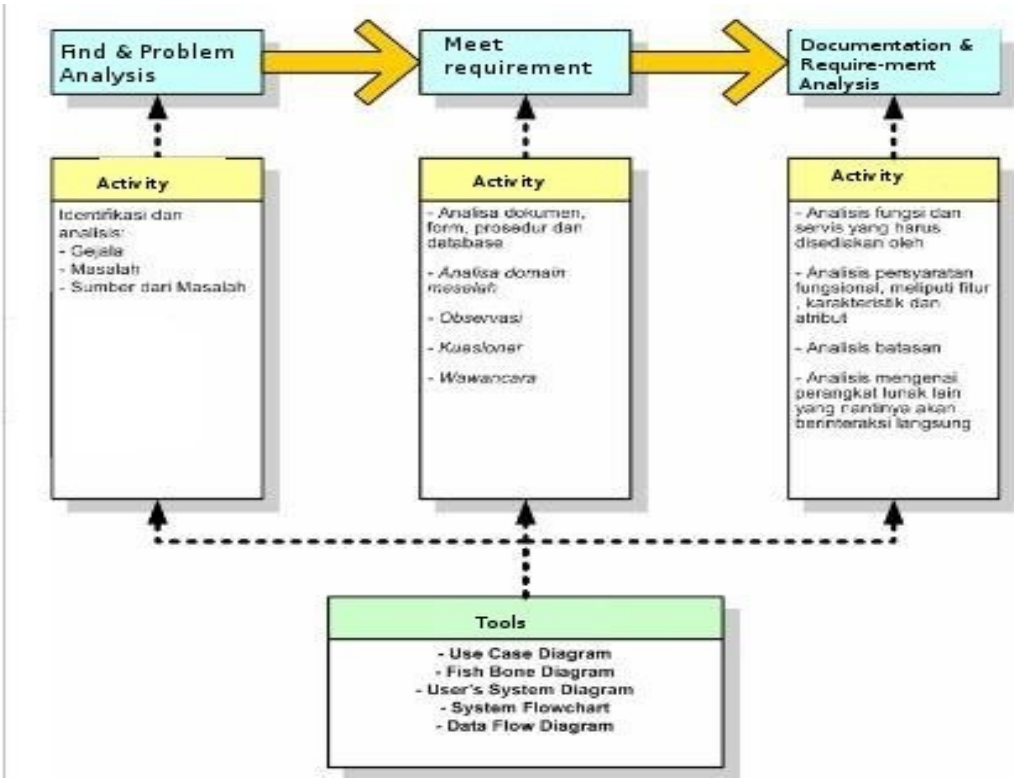
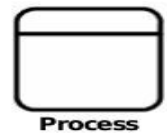


Figure 2.7. Stages and Activities in analysis.

There are generally four notations that often were used in DFD as shown in Figure 2.8.

External Entity symbolized the source of the data or the information recipient (the destiny from the data). External entity examples include the consumer who ordered a product, the manager who evaluated the report on the weekly sale, and so on.

Process is a series of stages to do data manipulation, such as, collection, sequencing, selection, reporting, and analysis etc.



Data store is the place to store the data prior to use. The name used in the data store is the abstraction of the stored data. However, details, items, how to access and how it organized is not explained in this notation.

Data flow shows the flow of data from one place to another. This data migration could be from external entity to a process, between processes, from a process to data store. In the drawing, each data flow must be given a label to identify the data.

Figure 2.8. Notation in DFD.

In creating DFD, there are several stages to be carried out in sequence. Figure 2.9. shows the sequencing of the stage.

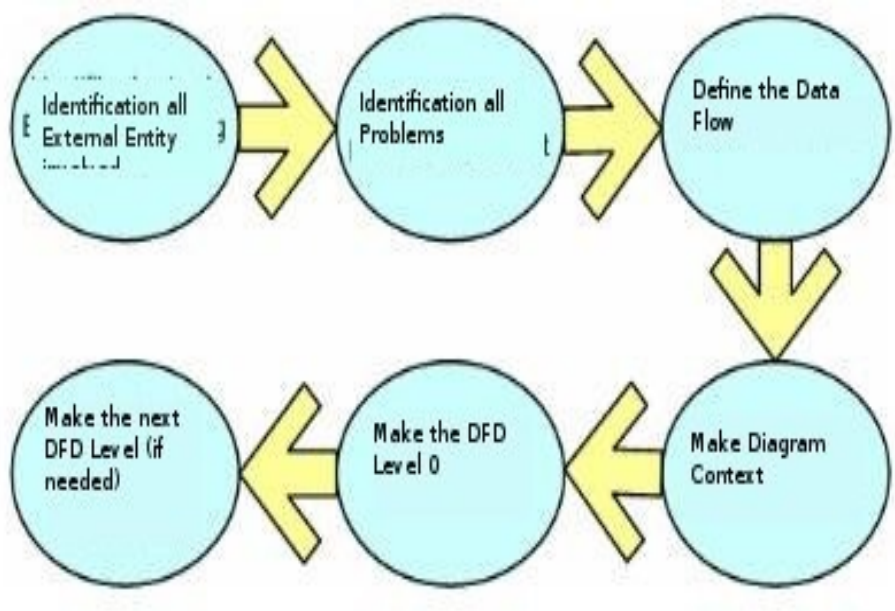


Figure 2.9. Stages in creating DFD.

Context the diagram is DFD scope of the system to show system boundaries, external entities that interact with the system and the main data flow between external entity and the system. Context diagram shows overall system as a single process. Figure 2.10 shows an example of context diagram.

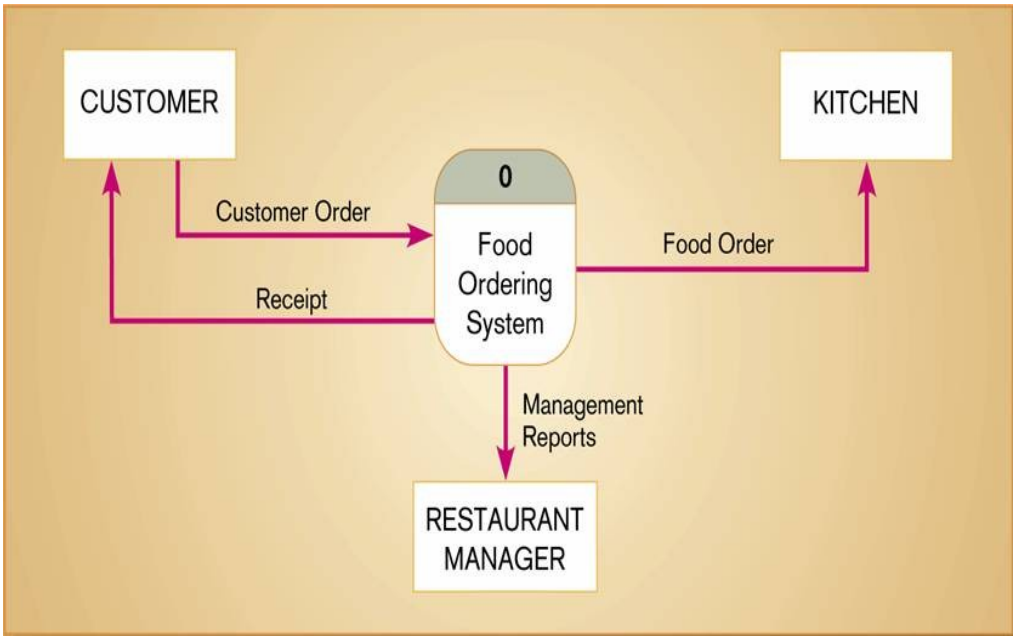


Figure 2.10. Context diagram of food ordering system (Hoffer et.al., 2002).

Context diagram in Figure 2.10 shows a single process to represent the modeled system. The process is given notation 0 to show this is the most abstract level of the system. Moreover, there are three (3) external entities, namely, customer, kitchen and restaurant manager. The three of them could play as data source (in the above example is customer) or as the information recipient (in the above example is customer, kitchen, and restaurant manager). Data flow is apparent in the picture shown to have one data flow enter the system and have three (3) datas flow out of the system. Data flow is labeled to showed the what data is flowing, respectively.

After context diagram is correctly formed then detailing context diagram in DFD Level 0 would be the next step. DFD Level 0 is DFD that representing processes, data flow and main data storage in the system. DFD Level 0 this will be used as the foundation to build DFD below it (Level 1, 2, 3,.. etc.) or normally known as decomposition DFD. Figure 2.10 is DFD level 0 from context diagram in Figure 2.11.

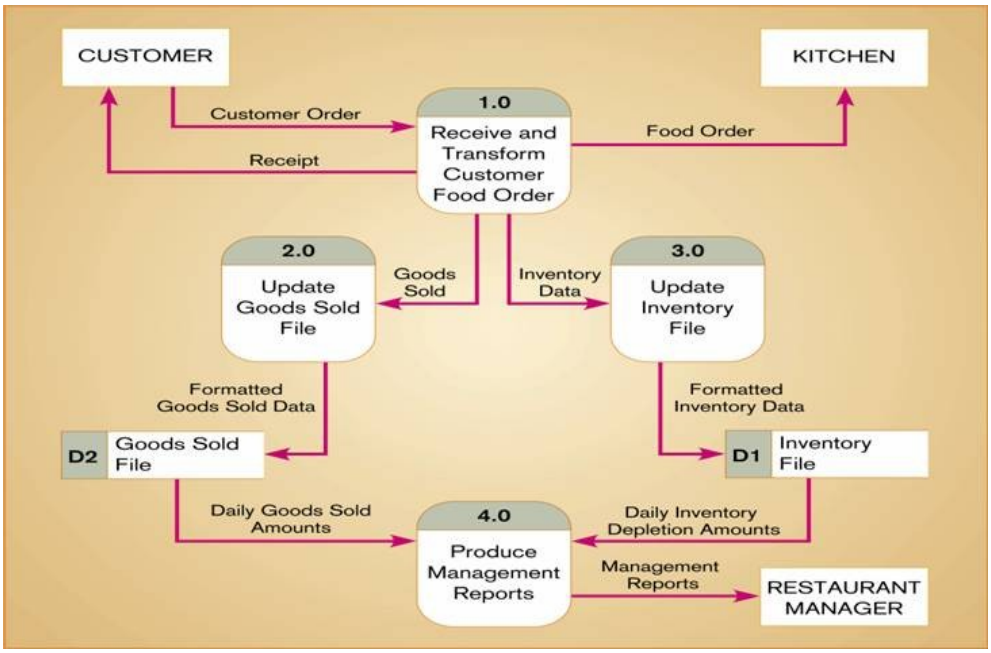


Figure 2.11. DFD Level 0.

Figure 2.11 shows the splitting of the process from one into four. Each process is numbered as 1.0, 2.0, 3.0 and 4.0, respectively. The total external entity must be fixed three (3) likewise input and output data flow in the system must be the same as in context diagram. Whereas data flow in the system (that flow between process and / or data storage) depend on the involved process and data storage. There are two data storage, namely, Goods Sold File and Inventory File. The two (2) data storage is used to keep the data from a process. The data will also be read / accessed by other processes. For example data storage Inventory File contained the data produced by process 3.0 (Update Inventory File). This data will be used by the process 4.0 (Produce Management Reports) to make the report that will be sent to the Restaurant Manager.

The next level in DFD, namely, level 1, 2, etc, is needed if current level is not detail enough. For example if DFD level 0 (Figure 14.12) is not detailed enough in showing the data flow, then it could be detailed in DFD level 1. Process is normally be the one that has to be detailed. Detail in the next level can be in all process or certain processes. DFD level 0 or the next level has similarities in the rules that shown in the following table.

Table 2.1. Rules in DFD

Group	Rules
General	● inputs to a process will always vary with the outputs. ● objects (External Entity, Process, Data Storage, and Data Flow), which is in a DFD always have a unique name.
External Entity	● Noun always used in the name of External Entity. ● Data can not flow directly from one External Entity to another External Entity.
Process	● The name used in the process always use verb. ● There is no process that only produces output. ● There is no process that only accept input.
Data Storage	● The name used in the Data Storage always use the noun. ● Data can not flow directly from the Data Storage Data Storage to one another. ● Data can not flow directly from the External Entity to the Data Storage also vice versa.
Data Flow	● The name used in the data flow always use the noun. ● Data flow between the two notation have only one direction of flow. ● Branching (fork) shows the exact same data that flows from one place to two or more places. ● Merging (join) the data shows an exactly the same data as that flow to two or more places. ● Data Flow towards Data Storage means to update the data. ● Flow of data from the Data Storage means reading / retrieving data.

2.2.2. Design

Software design is the task, the stage or the activity that focused on the detail specification of a computer based solution (Whitten et.al, 2004).

Software design often refers as physical design. While system analysis stage stress on business aspect, software design focuses on technical and implementation side of a software (Whitten et.al., 2004).

The main output from software design stage is the design specification. The specification covers the general design specification for the system's stakeholders and detailed specification to be used in the implementation stage. The general design specification contains the general picture of the software for the stakeholders. USD diagram on the software is normally the important point in this stage. The detail design

specification or the detail architectural software design is needed to do system design so as to have a good construction, an exact and accurate data processing, valuable, user-friendly and has a good foundation for further development.

The architectural design consists of the database design, the process design, the user interface design including input design, output and report form, hardware design, software and the network. The process design is the continuation of process modeling that carried out in the analysis stage.

2.2.3. Construction

The construction is the stage that translate the logical and physical design into computer program codes. Construction techniques and methods will be described in more the detail in this book.

2.2.4. Testing

System testing involves all planned user groups. The level of acceptance is evaluated by all user groups based on the determined criteria.

2.2.5. Maintenance and Configuration

When a software is considered appropriate to be used, the next stage would be the software maintenance. There were several software maintenance types known as shown in Figure 2.12.

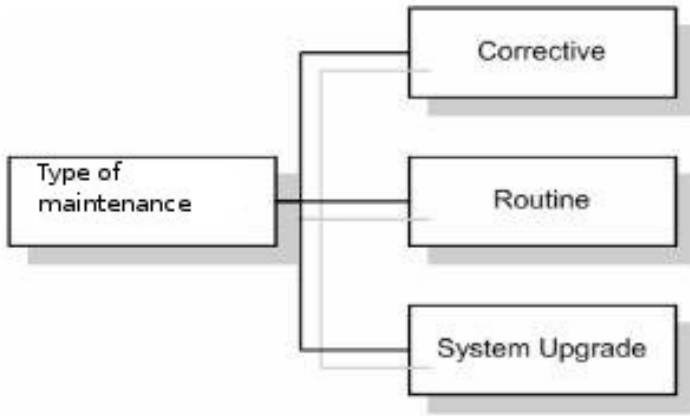


Figure 2.12. Maintenance Types.

Corrective maintenance is carried out to circumvent errors known as bugs. The maintenance Is carried out by improving the code, increased the some parts or eliminated certain parts.

Routine maintenance is also known as preventive maintenance is carried out routinely to maintain the performance of the software whether there is any mistakes / errors or not.

System upgrade maintenance is carried out to change any components of the software. For example, platform or operating system changed, old to new version change require upgrade of the software.

2.3. SUMMARY

- Software engineering models generally refers to the system development process modeling that was known as System Development Life Cycle (SDLC).
- Software development model used is generally the Waterfall Model, Prototyping, and Unified Process (UP).
- The main stages of software engineering covers the analysis, the design, the construction, the testing and the maintenance.

2.4 EXERCISE

Name stages in System Development Life Cycle (SDLC).

1. Name the similarity of various software development models characteristics.
2. Name five software development models.
3. What is meant by construction stage in software engineering?
4. Show the notations in the Data Flow Diagram.