

CHAPTER 3

SYSTEM METHODOLOGY

3.1 Introduction

Methodology is an early phase in development system. It is included into this chapter to see how the project will be developed. A plan must be drawn up to guide the development towards the project goals. Methodology is the study of methods or a body of method. It may be defined as a collection of procedures, techniques, tools and documentation aids. These may help the software developers to speed up and simplify the software development process. A methodology consists of a set of phases that in turn may consist of sub-phases. These phases are important in guiding the developers to the choice of techniques at various stages in the project. Additionally, a methodology helps the developers to plan, manage, control and evaluate information system project.

A lot of methodology models in existence currently, after done several researches on methodology, researcher decided to have multi-method research. The methods are system dynamics methodology for developing a human resource planning model and prototyping methodology for web-based development. Multi-methods research involves using more than one type of research technique or data source within a study. It was argued that using multiple methods could enhance confidence in the findings, in particular by increasing the ability to evaluate convergent and discriminant validity. Multi-strategies research may be a better way to conceptualise research designs involving qualitative and quantitative elements (Bryman, 2001).

Qualitative element used for this project is observations on human resource planning in Telekom Research & Development to see the pattern in how they recruit a researcher and informal discussion with human resource staff and also informal discussion with researcher's colleagues whom are experts in system dynamics. However, quantitative element used for in this project is doing survey by using questionnaires to collect information from samples. This chapter discusses the relevance of research methodology chose for this project such as information collecting methods, details of the methods and how the methods being designed to gather information, prototyping methodology as well as system dynamics methodology. The analysis of the data and the design of the human resource planning are discussed in the next chapter.

3.2 Information Gathering Methods

Information gathering methods are essential skill for all system analysts. It is a classical set of techniques used to collect information about system problems, opportunities, solution, requirement and priorities. In the following subsections, researcher will explain the information gathering techniques that applied in this project development.

3.2.1 Survey

Survey research is one of the most important areas of measurement in applied social research. The broad area of survey research encompasses any measurement procedures that involve asking questions of respondents. A "survey" can be anything from a short paper-and-pencil feedback form to an intensive one-on-one in-depth interview. The strength of the analysis depends on good quality data that in turn stems from good design

of the data collection instruments, i.e. the questionnaires, and of the collection procedures. The basic process of survey research can be outlined as follows:

- i. define research aims
- ii. identify the population and sample
- iii. decide how to collect replies
- iv. design questionnaire
- v. run a pilot survey
- vi. carry out the main survey
- vii. analyse the data

A crucial part of good research design concerns is making sure that the questionnaires design addresses the needs of the research. To put it in another way, somehow researcher needs to ensure that the questions asked are the right ones.

3.2.1.1 Define Research Aims

This thesis is about human resource planning for the recruitment of researchers in specific research organization. Researcher will start the survey by setting down the aims for the survey. To define the aims, researcher will need to review the relevant literatures and may need to do some preliminary research amongst the target subjects. The target subjects are human resource staffs and also researchers at Telekom R&D. This company has been chosen as a location of the sample because of the nature of this company that can fulfill the objectives of this research. Fulfilling these aims should then drive the

design of the questionnaires and help select questions that are relevant, concise and efficient.

Most researchers make the mistake of asking too many questions and complicated questions. This often arises from an incomplete analysis of how to meet the surveys' aims. The greatest enemy in survey research may well be poor response rate. When the questions asked are too many and complicated, this problem will affect the response rate. Clear and concise questionnaires can help get the best response. Respondents are more likely to commit to answer a questionnaire when they see it as interesting of value, short, clearly thought through and well presented. Once the research aims have been defined the next step is to identify the population and sample.

3.2.1.2 Identify Population and Sample

The population is simply all the members of the targeted group. A sample is a sub-set of the population that is usually chosen because to access all members of the population is unreasonable in time, money and other resources. A key issue in choosing the sample relates to whether the members that have been chosen are representative of the population. This project involved two groups of sample respondents that represent targeted people. There are two targeted groups of human resource planning system with different need and functionalities towards the research objectives. One is the researchers itself and the second one is human resource staffs. The sample is chosen randomly from a list that contains all the members of the population; such a list is called a sampling frame.

To determine the sample size it is usual to work back from how many responses (completed questionnaires) are required for analysis. One rough and ready rule is to look for about 20 to 30 responses in each of the major sub categories of the sample. The questionnaires for researchers were distributed to 50 respondents and human resource staff's questionnaires were distributed to 10 respondents only.

3.2.1.3 Questionnaire Design

Questionnaires are usually paper-and-pencil instruments that the respondent completes. Interviews are completed by the interviewer based on the respondent says. Sometimes, it's hard to tell the difference between a questionnaire and an interview. For instance, some people think that questionnaires always ask short closed-ended questions while interviews always ask broad open-ended ones.

Any question can be asked assuming it is put in a proper frame of reference and the respondents have the knowledge and are willing to respond. Filter questions can distinguish those individuals who cannot respond appropriately to a question. The biggest difficulty in preparing survey questions is deciding on the actual words to put into the questions. A question that seems straightforward to one person may appear very complicated to another. The goal of writing questions is to have the question mean the same thing to every respondent. Generally, it is suggested that use the simplest words possible. The questions must be understandable, it must be clear what the respondent is supposed to do, the respondent must be able to respond and the respondent must be willing to respond.

Researcher must be very clear in his or her own mind what information requires so that appropriate questions are asked in appropriate ways. Researcher must be very clear what information are going to be provided by each question and how this information relates to the original purpose or objective of the research. Designing good questionnaires involves creativity and precision. The researcher must ensure that each question has a specific purpose which relates back to the research aims and questions. It is also very important to know how to analyze the results received must have a clear idea of how the data will be dealt with. Before going further with steps involved in developing good questionnaires below are tips for designing questions:

- i. Clarity of language is important. Researcher must avoid using slang, colloquialisms or jargon.
- ii. Understanding of different terms – ensure consistency throughout the survey and use terms that are easily understood.
- iii. Length of questionnaire must avoid overlong and avoid complex questions.
- iv. When considering the types of questions to ask, consider the structure of the question and avoid double barreled questions that ask two things at once.
- v. Bias within questions or with language. Means that it is biased when it causes someone to answer in a way that does not reflect his or her point of views.
- vi. Do not ask irrelevant or illogical questions.

- vii. Be careful about using abstract concepts that do not allow a precise answer.

The tips for designing questions were very useful to researcher. They really help researcher understanding more on how to make a good questionnaires. The first step in designing a questionnaire is determining the questions to be asked. This step is a key one that seems not to be sufficiently stressed in the literature or conducted in practice. The research aims and the individual questions needs to be established via the research issues. Issues and questions can be determined through a combined process of exploring the literature and thinking creatively.

The second step is deciding on a layout and sequence. A brief introductory statement is useful, especially if the introductory letter could go adrift. Contact and return information should be included on the questionnaire. It is good practice to number or otherwise identify individual questions for reference purposes; this is particularly helpful to deal with queries during the data entry and analysis stage. Lay out the questions and answer choices attractively and neatly. The wording must be consistent and try to standardize by using as few question types as possible.

The next step in designing a questionnaire is question types. Survey questions can be divided into two broad types: structured and unstructured. Structured question is a question that can only be answered in a specific way for example the answer must be

yes/no or true/false. Unstructured questions are rare and do not provide a plan. In this project researcher only used structured question in designing the questionnaires.

Before researcher start to design questionnaires, researcher must have a very clear objective. There are two types of questionnaires designed. The first set of questionnaires is mainly for researchers and the other questionnaire is for human resource staffs. Both questionnaires consist of three sections. The objective of questionnaires in *section I* is to get the answers that will be used as default value in the human resource model. Section I in human resource questionnaires is basically a demographic or an introduction of the company. It will give information about the number of researchers, how much grant per year, number of projects, how many projects being proposed every month and project's duration. However, the objective of *section I* from researcher's questionnaires is to get information about the background of researcher itself. For both questionnaires in Section II the main objective in this section is designed to help companies evaluate their human resource practices. If the total score for 'yes' responses is less than 10 it means that the organization is in need of the introduction of basic human resource programs. Total score from 10 to 12 means that the organization has the potential to benefit from human resource programs. For the result of total score 'yes' responses from 13 to 14 explains that the organization is doing many things right. Lastly, if the total score is 15 'yes' responses, it means that the organization is doing an exceptional job at providing human resource programs. The objective of the last section is to get researchers' and other staff's opinions regarding other matters like benefits of the company, what other fields that need to be improved, as well as the future of R&D company.

The questionnaires for this project include dichotomous questions or closed questions, Likert response scale and multiple-choice questions. Examples of each of the question used in this questionnaires project as follows:

i. Dichotomous questions or Closed-ended questions

A dichotomous question is a question that has two possible responses. Survey often used this kind of questions that ask for a Yes/No, True/False or Agree/Disagree response. These questions are useful in checking facts. There are a variety of ways to lay these questions out on a questionnaire:

Does your company send researchers for training according to their project requirement?

☐ *Yes*

☐ *No*

ii. Likert-scale questions

A Likert scale is a type of psychometric response scale often used in questionnaires and is the most widely used in survey research. Here, researcher might ask an opinion question on a 1-to-5 bipolar scale (it's called bipolar because there is a neutral point and the two ends of the scale are at opposite positions of the opinion):

High caliber, qualified, experienced and knowledgeable is a must to be a good leader.

*1
Strongly
disagree*

*2
Disagree*

*3
Neutral*

*4
Agree*

*5
Strongly
agree*

iii. Multiple-choice questions

Multiple-choice question was considered when researcher wants respondents to pick the best answer or answers from among all the possible options. This type of question consists of a stem and a set of options. Researcher used this type of question to get organization information. Below is an example of multiple-choice question.

What is your area of expertise?

- a. Information Technology*
- b. Engineering & Telecommunications*
- c. Computer Science*
- d. Others Field*

After choosing the questions type, the next step in designing questionnaires is to decide on question wording. Below are some general rules that can be stated on question wording:

- i. Be concise and unambiguous
- ii. Avoid double questions
- iii. Avoid questions involving negatives
- iv. Ask for precise answer
- v. Avoid leading questions.

Questionnaire is a long process that demands careful attention and lots of time. A questionnaire is a powerful evaluation tool and should not be taken lightly. A design

begins with defining a research aims and how they can help in the research and end with analyzing the data collected from the questionnaires. When the guidelines are followed, the questionnaire becomes a powerful and economic evaluation tool.

3.2.1.4 Run a Pilot Survey

When designing questionnaire has been completed, test the questionnaire on a small sample number of surveys before conducting the real survey. This is running a pilot survey. The aim in running a pilot survey is to detect any flaws in the research questioning and correct these prior to the main survey. The questionnaire was given to a few individuals from system dynamics group and they gave their opinion on the questions. The individuals answered the questionnaire and their responses were analyzed to be considered in the questionnaire modifications.

Having done the pilot survey, researcher can make amendments that will help to maximize the response rate and minimize the error rate on answers.

3.2.1.5 Carry out the Main Survey

The main survey was carried out after amendments had been made from the pilot survey. The questionnaire was delivered to the respondents. Here the researcher followed through on the decisions made earlier about how the questionnaire should be administered and who the respondents should be as stated in the first step in survey processes. Deadlines

for distribution have been decided earlier before starting to contribute the questionnaire to respondents.

3.2.2 Other Method

Other method used in this project is informal discussion with the person or staff involved in recruiting new researchers; head of department and with all my colleagues in system dynamics group. The other two methods are via internet surfing and reading materials or journals. Brief explanations regarding the other methods being used in this project are as below:

3.2.2.1 Informal Discussion

Informal discussion is one of the methods in collecting data. Basically, Informal discussion means a conversation between a person eliminated from consideration in the internal appointment process and the decision-maker. Discussion must involved two or more people. The purpose of informal discussion is to share information or to get information in informal way. Informal discussion is meant to be informal. With no set rules or format, informal discussion is intended to be a free-flowing and frank conversation between researcher and system dynamics group members. During the development of this project, researcher had several discussions with the human resource staff. After capturing all the information needed from them, then researcher only had informal discussion with system dynamics group. Members in system dynamics group have been given lots of information, opinions and guide the researcher in developing the modeling using system dynamics methodology. They are really experts in system

dynamics and have experienced developing system dynamics modeling more than 10 years.

Informal discussion promotes transparency and is intended to improve communication during the process before a final decision is made. Informal discussion is similar to the post-board feedback. But unlike the post-board, informal discussion is available at any stage during the appointment process. From time to time researcher had informal discussion with system dynamics team members until the final modeling has been modeled and ready to be used in the web development process.

3.2.2.2 Internet surfing

The internet is a platform where a lot of information can be acquired. With development of each search engines such as Google, Whatis and Yahoo!, relevant information site can be view with only a click away. Lots of information can be collected for literature review, especially the technology review. Besides, on-line tutorial regarding programming language can be also obtained through surfing the internet. In order to get more knowledge in system dynamics researcher had subscribed in powersim group. Powersim is a tool that allows researcher to build advanced dynamic simulation models of the system. Any problem faced with powersim, researcher can ask all members in powersim group. Researcher will get updates regarding the software from powersim newsletter.

3.2.2.3 Reading Materials/Journals

A lot of published literatures have been read in order to gather information of the users' need, system development's needs and technical issues of the proposed system. All these can be categorized into printed materials such as books and journals and non-printed materials such as electronic documents. Ideas are managed to get from books, magazines and journals through reading. These ideas can be implemented in the proposed system.

3.3 System Dynamics Methodology

The research methodology is based on the SD methodology proposed by Forrester in 1961 and is depicted in Figure 1. According to Jay W. Forrester, the pioneer in system dynamics research, the structure of a system can be identified in the following way (Forrester, 1975):

- i. A system boundary comprises all components - no more but no less, either which are required for the comprehension of the system behavior observed.
- ii. These system components are interconnected in the form of feedback loops.
- iii. The feedback loops consist of two and only two distinct kinds of components which are stocks (describe the state of the system at any point in time) and flows (describe the temporal dynamics of the system).

The SD methodology aims to analyse complex complex systems and problems, using computer simulation software. Jay Forrester created a methodology for analyzing complex systems to aid and improve decision-making and policy formation (Meadows, 1974). This methodology could also be used to include relevant cause-effect relationships, delays and feedback loops in complex system to account for the unexpected behavior.

SD is an experimental approach to System Analysis. It is a way of understanding complex systems and modifying or changing them in some way. It also an approach for validating and assessing the consequences of implementing analytical (prescriptive) models or recommendations of a case study report. SD is both a theory of structure in systems and an approach to policy design.

SD models are essentially simplifications of reality based on the analyst's understanding of the system and assumptions made regarding expected behavior. SD modeling in management sciences proves to be an extremely useful tool. However the tool does not guarantee accurate prediction of future behavior.

SD models are mainly used for:

- i. Policy testing (Forrester, 1961)
- ii. What-if scenarios (Morecroft, 1988)
- iii. Policy optimization (Kleijnen, 1995)

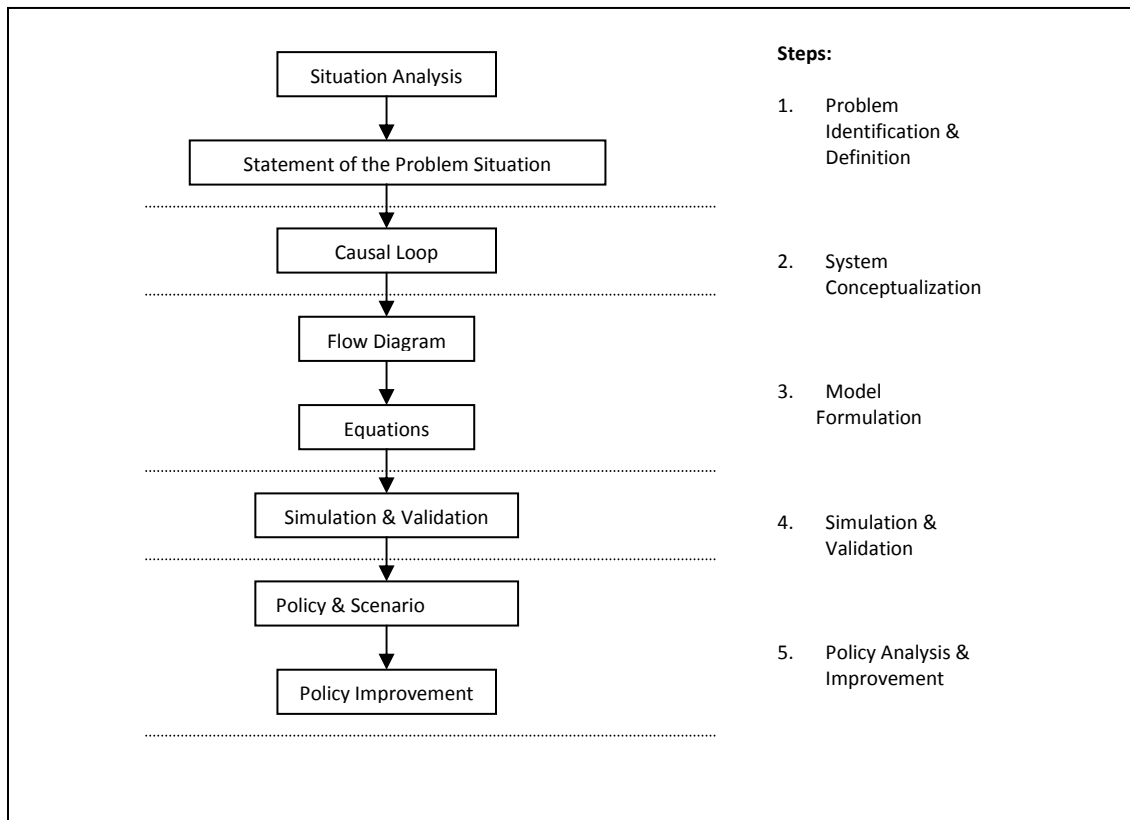


Figure 3.1

System Dynamics Methodology

3.3.1 Problem Identification & Definition

When creating a dynamic simulation model, researcher or modeler should always start with a problem definition from the real-world. This is a requirement if modeler is going to succeed in setting the limits of the model correctly. The problem definition must describe the key criteria for success for the project, define the boundaries of the simulation, and identify the user of the simulation. Modeler will find the correct aggregation level that is correct for the problem at hand. It is also useful to start the mapping process of the basic structures of the human resource planning to identify the information that is required to carry out the project. Some of this information is already available within the target organization, while some of it must be collected during the project development process. When modeler has found the problem definition and identified what part of the “real-world” modeler are working with, modeler must start observing how the “real-world” system works in reality.

3.3.2 System Conceptualization

The data collection is the process of collecting the available information (such as key performance indicators), as well as identifying the "white spaces" in the organizations own knowledge of the business process. Many organizations may already have implemented different strategic decision tools, such as Business Balance Scorecards. Such solutions offer valuable insight to help identify the most important driving factors of the business process. By collecting and analyzing data from the questionnaires, the result from the questionnaires can be used as a default value in human resource model.

By identifying these factors, modeler can identify the causal relationships of the target organization business process, which will be modeled in the simulation model at a later stage in the modeling process. Once the various bits and pieces of information are gathered, it must be structured in a way that allows us to see how they are related. Modeler must identify which of the many factors identified above, is crucial in order to solve the problem defined.

3.3.3 Model Formulation

The next step is to decide what the model is going to look like. In this step modeler will build the model itself, based on the analysis performed above and based on the discussion with the all person involved in this project. Modeler will in this process develop the model from a *structural qualitative model* and into a *mathematical quantitative model*. It is often useful to start by creating a causal-loop model to identify the feedback structures of the system. Modeler must identify the variables that are going to be presented in the model, and modeler must also set the limits of the model. These limits will decide where and when modeler should stop looking for cause-and-effect relationships.

Finally, modeler must decide which factors should be able to control manually when run the model, and how this input should be achieved. The outcome of this step will be an intermediate version of the dynamic simulation model.

3.3.4 Simulation & Validation

When modeler has a first model available, it is time to see how the model behaves. By running test simulations, modeler will be able to see how key variables in the model behave over time. By altering parameter values during these simulations, modeler can see the effect these parameters have on the model structure. The important issue in this step is to verify that the model behaves reasonably, and to identify problem behavior and find fixes for them.

When modeler has created a simulation model that apparently describes the system well, it is time to compare the simulation model to the problem definition identified in the first phase of the project. This will prevent from building a model that starts to deviate from the original plans and that may not shed light over the problem it was originally intended to do. Modeler can also compare and validate the model towards the observations already done on the real-world system. A model can be validated on several criteria. Modeler should evaluate whether the behavior of the model is acceptable and that it reproduced the data modeler have collected in a satisfactory manner (within reasonable limits). Another important issue is whether the boundary set for the project are still relevant, or whether elements needs to be included or excluded from the model.

3.3.5 Policy Analysis & Improvement

Based on the strategic alternatives and policies built into the simulation model, modeler can experiment with the simulation and test and analyze the consequences of various decisions. The simulation is a micro-world that let modeler test out the decisions in a safe environment. The simulation allows modeler to test out various scenarios, and to assess the risks associated with them. Other strength is that modeler can perform other analysis to the target organization, as well. In addition to analyzing the effects of decisions have on the organization, modeler can also test out how the organization reacts to unforeseen external events. That way modeler can also create policies for and be prepared for situations that might arise in the future.

The simulation model may yield several possible strategies to solve the original problem. It is up to modeler to decide which strategy should implement. Based on the knowledge gained by the simulations, modeler is better equipped to select the one that solves the problem in the best way. When modeler has identified the strategy that is perceived as the best from the simulation, it is time to implement it in the organization. At this point, the simulation model may serve different purposes. Modeler can use it as a planning tool, helping in conveying the organization's strategies in hiring a researcher, other employees, or stakeholders. It may be used as a training tool for researchers, helping to build their knowledge and increase their skills, or modeler can continue to develop it to deal with more specialized problem definitions.

After implementing strategies in the real-world system, modeler should also make sure to check the results towards the simulation. If the examination shows that the model

behavior and prediction was not satisfactory, modeler can go through the inner modeling loop, and experiment further with model before implementing new strategies. Most business will go through a constant development, and new challenges will constantly be met, requiring new strategies to be made and implemented. Keeping the simulation model up-to-date with regards to new markets, competitors, organization changes, and so on, allows business to keep a fully functional decision support tool at any time.

3.4 System Development Methodology

System development methodology is a collection of techniques for building model-applied across the web-based simulation lifecycle. A model is process of simulation development which used for now; and later by software engineers or system developers to describe their approach in developing web-based simulation. Methodology is an early phase in development system. It is included into this chapter to see how the project will be developed. A plan must be drawn up to guide the development towards the project goals. There are a lot of methodology models in existence currently. Besides using system dynamics methodology in developing a human resource model, prototyping methodology will be used in developing web-based simulation.

The American Heritage Dictionary gives the following definitions for a prototype (Petra Neumann, 2004):

- i. An original type, form or instance serving as a basis or standard for later stages.
- ii. An original, full scale and usually working model of a new product or new version of an existing product.
- iii. An early, typical example.

Prototyping is the process of quickly putting together a working model (a prototype) in order to test various aspects of a design, illustrate ideas or features and gather early user feedback. Prototyping is the process of building a model of a system. Methodology is important because it should be able to teach, to schedule, to measure, to compare and to modify. The difficult part in this project was developing system dynamics modeling, so prototyping is the best and the most suitable methodology in development of web-based. The development of prototypes is useful for a number of different reasons. The reasons were:

- i. Early validation of applications with users.
- ii. Users can take an active part in the development of a project.
- iii. Users are encouraged to share needs and wishes for the final prototype.
- iv. They produce more visible results earlier.
- v. Improved collaboration & communication among researcher and respondent or user of the system.
- vi. Encourages reflection about the project.
- vii. Finds answers to questions about the design
- viii. Prototypes are very easy to build and this will save more development time.

- ix. Reduced risk of project failure. This is the main reason why researcher has chosen this methodology.

All those reasons will make the development of web-based simulator faster. Prototyping can take place at different stages in the development cycle depending on the goals of the prototype. For different goals different prototyping techniques should be used at different stages. Figure 3.2 gives an overview of how different prototyping categories can be included in the design life cycle.

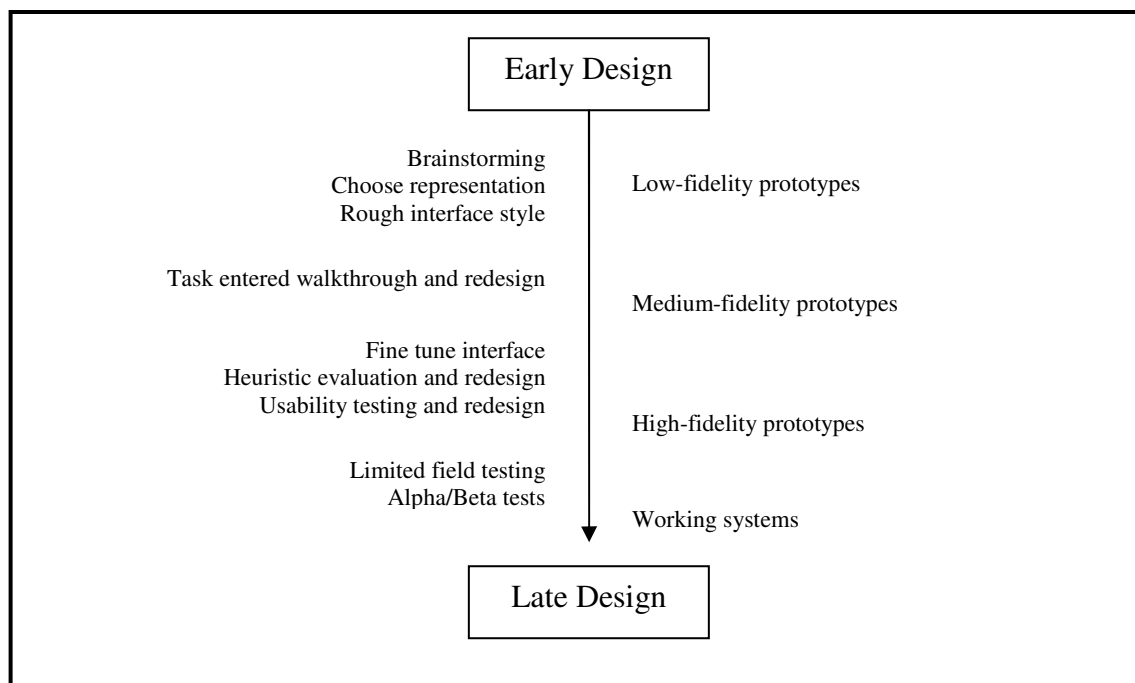


Figure 3.2

Prototyping in the design life cycle

An important part of prototyping involves testing the prototypes on potential users. It has been shown that usability evaluation of prototypes, even with those of low-fidelity can be very effective. Evaluation of prototypes can be conducted throughout the design lifecycle (figure 3.2). It has been found that prototyping is very effective in the analysis and design of on-line systems, especially for transaction processing, where the use of screen dialogs is much more in evidence. The greater the interaction between the computer and the user, the greater the benefit is that can be obtained from building a quick system and letting the user play with it. The prototype application at the time of writing this chapter includes:

1. A page for introduction or home.
2. A page for setting the simulation running time.
3. A page with a form to receive the user's input assumption about project.
4. A page with a form for the user's input assumption about staffing.
5. A page for presenting the results of simulation represent in graph and table.
6. A page about the simulator.

3.5 Conclusion

This chapter presents the methodology used in web-based simulator development which consists of two methodologies. The first methodology involved in this research is System dynamics methodology and the second methodology is prototyping for web-based development. The system dynamics methodology was applied to develop a model of human resource planning. Numerous tests were conducted to ensure that the model building research is rigorous and accurate. It also covers a few methods that have been used to collect information for the research purposes. Various techniques of information gathering such as online surfing, reading materials, review of past research and journals have been practiced, informal discussion with superior and human resource staffs in Telekom Research and Development as well as project supervisor. Research analysis will be discussed in the following chapter.