Chapter 3 Research Methodology

3.1 Waterfall Model

![Basic Waterfall Model Diagram]

Figure 3.1: Basic Waterfall Model

The Figure 3.1 (Rosenbat, 1987) illustrates the basic waterfall model, which is one of the main system development models. In this model, stages were set as a series of sequential steps with the flow of time and information from left to right. The model defines the order of stages that will be delivered completely to the management at the end of each stage. This is a long used traditional model and all the plus points and the drawbacks have been identified clearly. It is also the most widely used methodology in the software development industry.

3.1.1 Advance Waterfall Model

The new waterfall model, which is known as the Advance Waterfall Model have been explained in the Figure 3.2 (Gary, 1999). It allows returning to the previous stage when the need arises but this provision should be used with care. This advantage is important in software developments as it is considered a plus point of this model. It is
undesirable to change the specifications of the previous phases to accommodate new requirements. However this model does allow this to provide the flexibility to incorporate important requirements found later in the development process.

3.2 Waterfall Implementation

Below are the 5 stages from the waterfall model that will be used in the development of the new system.

3.2.1 Requirement Analysis

The waterfall model implemented in this research is preceded with the requirement analysis. In this phase, the requirement of the new system is to be
identified. All the requirements for the system were gathered with employing techniques such as questionnaires, interviews and survey.

Interviews are done with the key personals in the agency and from other agencies to get a clearer idea of the industry and the business activities involved. Questionnaires are given to their customers and survey is done during their business process to understand the business needs. All the information will be analysed and all the functional and non-functional requirements of the new system will be engineered.

The scope of the development efforts will be determined. Developers will understand what the proposed system means more in the technical way and how it will be incorporated into the existing business flow. Then the VCA is carried out on the system’s suggested functions. Both Cost Benefit Analysis (CBA) and the Present Value Analysis (PVA) models were used to strengthen the VCA.

### 3.2.2 System Design

This scheduled is followed by the next stage in the waterfall model, which is the system design phase. In this part, requirements of the project will be translated into detail design. The dataflow diagram (DFD) will be used to link the whole system with this specification. As generally known, DFD will provide detailed information regarding the flow between the information and the tables involved. This will also give a clearer idea of the tables that is needed.

This is followed by the Normalisation method. All the tables will be created and normalised to the third level to minimise its dependency and redundancy. Primary and Foreign Keys in each table will be identified to enhance the database. After identifying the normalised tables, a complete database for the system will be created. The database design will be equipped with detailed description of each attribute by field name, data-type, data validation and description respectively.
Next part in the designing will be the Entity Relationship (ER) diagram. The relationship between every table in the database will be explained in this diagram. The ER diagram also examines the relation and the dependency of the tables.

Interface design is the final stage in the designing. It is one of the main components in system design. Only the necessary data should be provided in each page and confusing labelling should be avoided. All the irrelevant information in a page should be avoided to reduce mistakes made by the users. Not much graphical notation is required in this system since most of the users are assumed to be computer literate.

3.2.3 System Development

This is the phase where all the designs will be translated into machine-readable coding. The coding should be done keeping in mind the future enhancement and the system reliability.

3.2.4 System Testing and Implementation

The complete software will be also tested based on the functional and non-functional requirements. Each components of the software will be tested separately to ensure error free software and component integration.

The testing activity includes the involvement of computer technical people and customers. The testing log will include information on the program, tested item, expected action or value and remark criteria. In this research the testing will be done based on the actual data to know the system’s performance in the real life-working environment. In this phase the test reports are to be documented carefully.

The system implementation process concentrates on how the developed system plan to be implemented in the advertisement agency. A general study on how the
advertisement management system can be implemented in a typical manual based
Malaysian advertisement agency is studied in detail.

3.2.5 Discussion and Conclusion

The effect of the VCA in the system development will be discussed at this stage of the research. The new system will be reviewed to measure the system’s performance. The additional and minus points of the system will be discussed at this stage of the research and future suggestions will be addressed as an input to the next phase. Finally, the conclusions will be made on the implementation of VCA in system development.
3.3 Justification of Methodology Selection

The methodology selection brings many benefits towards the final delivery of the proposed system. The selected methodology incorporates systematic development technique to the project. This approach will create a more scalable system as it models the real world via abstraction.

The selection of Waterfall Model (WM) will encourage planning before designing and enforces some important rules in the process of developing the proposed system. It breaks the system into sub components with milestones corresponding to the completion of intermediate products. Since the WM is a discipline approach, it requires each stage of the software development to be documented. Besides that, the correctness of the product is checked on each stage of the product building. This ensures only the correct product that fulfils the users requirement are build during the whole development process.

Any mistakes can be rectified easier since all the activities will be documented at each stage completely. The quality of the product at each stage can be identified and maintained to meet the requirements.

The specification, design, printed code and other documentations such as the user manual are essential tools for maintaining the system. As this will be a booking management system and need to be error free, more time was spent to design the system at each stage and communicate with the people from the agency. The WM is a disciplined approach allowing each stage to be completed before moving forward.
The maintainability of the system have also been simplified since there will be an administrative for important tables where the critical information will be stored. This will simplify the whole process of managing the tables.

Another main reason for choosing WM is that it is a stable and reliable model. As it is widely used in the industry for a long time its reliability is tested and proved. The developers are also familiar with this model, as it is classic and popular. Due to the limited time in the software development process, using a stable and familiar model ensures reduced misunderstanding and problems in the system.

3.3.1 Customer’s Point of View

Besides that, from the customer’s point of view, they have very little experience in the new advertising industry such as television and printed media industry. This causes them to provide little information about the working flows in these industries. Thus, they have arranged few key persons from other agencies to be interviewed to understand more about these advertising options. This is because the understanding on an industry is important to cater the needs of the research.

Therefore, the key personnel’s will be present for the interview only once and all the necessary information needed have to be collected during the meeting. This is the main reason that limits option in choosing the process model and approach of the program. Since the usage of complex methodologies such as the spiral model and the prototyping method will need the participation of the outside key persons more frequently, it is more appropriate to commence the AWM.

The usage of the AWM need the users participation only once in the requirement gathering. Once in the stage of finishing the project, the advertising agency that the research is being studied on will gain more experience due to the time duration
taken to complete the whole project. Therefore, they will be able to use it and give their feedback. They will also be able to test it and check the reliability and accuracy of the system.

3.4 Cost Benefit Analysis

3.4.1 Profit Factor

This part of the research is a continuation work done based on the key calculation formula (Ward and Peppered, 2004) used in the VCA which have been explained earlier in chapter 2 (section 2.9). A sample calculation is included as an example to allow better understanding on the explained formulars.

![Figure 3.3: The Calculation Formula of Value Chain Analysis](image)

<table>
<thead>
<tr>
<th>Value added (V) - cost (C) = profit (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V - Value added by the improved methods (system in this research)</td>
</tr>
<tr>
<td>C - The total cost occur to develop or apply the better method (implementation of new system)</td>
</tr>
<tr>
<td>P - The measurable significant profit from the new method (new system)</td>
</tr>
</tbody>
</table>

The formula in Figure 3.3 appears to be an easy looking calculation at a glance. But to evaluate and estimate the exact cost of their respective value it is a complex task. Analysing the situation, the Cost benefit Analysis (CBA) is used in this research to compute profit (P) from the system to the agency based on the cost and the values added by the system. The CBA’s definitions and the working method in this system development have been explained further in sections below.
3.4.2 Cost Benefit Analysis

The simple explanation of the CBA (Guan, 2002) will be evaluated quantitatively whether to follow a course of an action. It is also an intensely creative tool, in generating solutions to a rigorous problem. Where most of the other methods stop in deriving the solution, the solution may still not be worth implementing, as it may invest a lot of time and money in solving a problem that is not worthy of this effort. But CBA evaluates the worthiness of the solution from the cost recovery factor.

CBA is a widely used technique in deciding whether to make a change. It is an effective method that rather than a simple tool to be used. As its name sounds, the basic arithmetic of the tool is the sum of value of the benefits of a course of action (benefits from the new system in this research), and deducts the associated cost.

\[
\text{CBA} = \text{Total Benefit} - \text{Total Cost}
\]

Figure 3.4: The Cost Benefit Analysis Formula

3.4.3 Tangible Cost

The costs in the system development are estimated and normally divided into two main parts. The one-off and ongoing maintenance cost, especially in a computer system. The one-off cost refers to the system development cost that includes the hardware cost, software cost, development cost, stationary and other cost.

1. **Hardware Cost**

   - The hardware’s where the new system will be implemented. Since the agency operates based on a file-based system, purchasing new hardware is essential. A suitable computer configuration will be decided based on the system’s need.
2. **Software Cost**
   - The total cost of the software will be purchased for both the software development and maintenance of the system. The software will be chosen based on the systems requirement and competency. This is essential to provide future support and to ensure the software’s stability and reliability.

3. **Development Cost**
   - The total cost involved in the project development will be calculated. This development cost will be equipped with detailed calculations including the working hours of the project manager.

4. **Stationary**
   - The stationary costs occurring in the development are the stationeries used such as the pencils and papers from the early stage planning. It includes all the stationery cost, used while the whole development process of this research.

5. **Others**
   - This refers to the other cost that is involved during the developing process of the software. It includes utility, transportation and other expenses. Most of the times these elements of the cost are ignored but it can consume a significant amount if it is not managed properly. Sample amounts are included in the Table 3.1.

Table 3.1: Sample Calculation of Total Development Cost of the System

<table>
<thead>
<tr>
<th>System Cost</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware cost</td>
<td>RM 4000.00</td>
</tr>
<tr>
<td>Software cost</td>
<td>RM 6000.00</td>
</tr>
<tr>
<td>Development cost</td>
<td>RM 16000.00</td>
</tr>
<tr>
<td>Stationary</td>
<td>RM 400.00</td>
</tr>
<tr>
<td>Others</td>
<td>RM 600.00</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td><strong>TC (RM 27000.00)</strong></td>
</tr>
</tbody>
</table>
3.4.4 Tangible Benefit

After calculating the cost occur (estimated cost RM 27000.00) in the development process of the system, the research is continued to identify the tangible benefits of the system. The tangible benefit will be derived based on the value adding functions. Given that it is difficult to calculate the accurate amount of the value of these functions, an acceptable amount will be fixed for each category selected. It is vital to remember that other than the tangible benefits being taken into consideration here, there are other intangible benefits such as the improved efficiency and reduced booking errors.

This amount will be totalled together and will be the value added amount to the formula in figure 3.3. The total cost TC equals to the cost (C) will be derived from the development cost of the system as explained earlier under the tangible cost section (section 3.4.3). The research is continued with listing and calculating the tangible benefits from the system.

<table>
<thead>
<tr>
<th>Tangible Benefits</th>
<th>Per Month</th>
<th>Per Year (x12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Staff Reduction</td>
<td>RM 1200</td>
<td>RM 24000.00</td>
</tr>
<tr>
<td>n.</td>
<td></td>
<td>TB (RM 24000.00)</td>
</tr>
</tbody>
</table>

3.4.5 Non Tangible Benefits

After listing and computing the total amount for the tangible benefits and tangible cost, the non tangible benefits such as the system’s efficiency and response rate will be listed.
3.4.6 Development Duration

By understanding the complexity of the system development, it is visible that the payback period might take more than a year and will be the ongoing cost of the system. But the value of the money spent on the project development and other cost will be different in the future.

The present value analysis is used to commence this problem. This is used to justify the money value at the present and the future. The shorter payback time (in years) shows the suitability of the project to be conducted from the CBA viewpoint.

3.5 Present Value Analysis Method

Present Value = Current Amount X Discount Factor

Figure 3.5: The Present Value Analysis Formula

3.5.1 The Purpose of the Present Value Analysis

1. The Figure 3.5 (Gannon, 1998) helps to calculate the value of the future expenses and benefits in terms of their present value (in RM).

2. Both expected benefit and cost will be substituted to calculate the respective monetary value in the future.

3. To compare the benefits of different projects with the period of different duration based on the current money value.

4. To compare today’s cost with the future cost and also to derive the current identified benefits with the assumed future benefits that can be gained from this new computerised system.
Figure 3.6: The Discount Factor Formula in the Present Value Analysis

The values for the expected benefit and the cost are derived based on the Table 3.1 and Table 3.2 respectively from the CBA section. The proposed project’s expected benefits over an estimated life span of N years will be counted based on the CBA and will be filled in a table shown in the Table 3.3. EB is the total expected benefit from the system.

Table 3.3: Template Table Showing Expected Benefit for N Years Lifespan

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected Benefits (in RM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RM 24000.00</td>
</tr>
<tr>
<td>2</td>
<td>RM 25000.00</td>
</tr>
<tr>
<td>N</td>
<td>EB (RM EB)</td>
</tr>
</tbody>
</table>

After that, employing the PVA method with an interest rate of 10%, the values will be gained and recorded to the following sample Table 3.4. The discount factor in the Table 3.4 and Table 3.5 is calculated based on the discount factor formula in Figure 3.6. The increase in staff salary and other business operational expenses should be included in calculating the expected benefit in Table 3.4. The recurring cost of operating the system also should be considered in calculating cost for the system cost in Table 3.5. Recurring cost is estimated as RM 2000.00 for system maintenance.
Table 3.4: Template Showing Value (Expected Benefit) after 10% is added

<table>
<thead>
<tr>
<th>Year</th>
<th>Expected Benefits</th>
<th>Discount Factor</th>
<th>PV of Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RM 24000.00</td>
<td>0.9091</td>
<td>RM 21818.40</td>
</tr>
<tr>
<td>2</td>
<td>RM 25000.00</td>
<td>0.8264</td>
<td>RM 20660.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total PVB</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>(RM 42478.40)</strong></td>
</tr>
</tbody>
</table>

Table 3.5: Template Table Showing Value (System Cost) after 10% is added

<table>
<thead>
<tr>
<th>Year</th>
<th>Cost</th>
<th>Discount Factor</th>
<th>PV of Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RM 27000.00</td>
<td>0.9091</td>
<td>RM 24545.70</td>
</tr>
<tr>
<td>2</td>
<td>RM 2000.00</td>
<td>0.8264</td>
<td>RM 1652.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total PVC</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>(RM 26198.50)</strong></td>
</tr>
</tbody>
</table>

3.5.2 Net Present Value (NPV)

\[ \text{NPV} = \text{Present value of Benefits} - \text{Present Value of the Costs} \]

\[ = \text{PVB} - \text{PVC} \]

\[ = \text{RM Value} \]

This research can be further enhanced with more comprehensive PVA as in Table 3.6. With such a complete PVA method, it would be easier not only to count the worthiness of the system but to also calculate the payback period more effectively.
Table 3.6: Template of Combined Present Value Analysis

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>RM 24000.00</td>
<td>0.00</td>
<td>1.0000</td>
<td>RM 24000.00</td>
<td>RM 0.00</td>
<td>RM 24000.00</td>
<td>RM -24000.00</td>
</tr>
<tr>
<td>1</td>
<td>RM 24000.00</td>
<td>27000.00</td>
<td>0.9091</td>
<td>RM 24545.70</td>
<td>RM 22314.50</td>
<td>RM 2231.20</td>
<td>RM -2231.20</td>
</tr>
<tr>
<td>2</td>
<td>RM 25000.00</td>
<td>2000.00</td>
<td>0.8264</td>
<td>RM 1652.80</td>
<td>RM 1365.87</td>
<td>RM 286.93</td>
<td>RM -286.93</td>
</tr>
<tr>
<td>n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.5.3 Conclusion of the Present Value Analysis

If the benefits are greater than the development cost and the payback period have a much shorter break event point so it is economically feasible to continue with this project.

3.6 Steps in Calculation

1. Understand Value Chain Analysis (VCA) formula
2. Substitute Cost benefit Analysis (CBA) formula to the VCA formula
3. Perform the CBA
4. Substitute Present Value Analysis (PVA) with the CBA values
5. Perform PVA
6. Final Value of the system
By following these steps, a complete and comprehensive amount can be derived to support the system’s continuation. The following Figure 3.7 explains the steps in stages. All the inputs and the output results at each stage of the analysis will be discussed in detail in Chapter 10 (Discussion and Conclusion).

Figure 3.7: Steps in Calculating Profit in a VCA using CBA and PVA