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Budget Advisor

Personal Financial Management Software

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Declaration

Hereby, I declare that this thesis is of my own work and has not been submitted in any form for another degree or diploma at any university or other institute of tertiary education. Information derived from the published and unpublished work of others has been acknowledged in the text and a list of references is given.

Mutahir bin Mohamed Ariff
5th September, 2002.

Abstract

The Budget Advisor software is a stand-alone application for use on personal computers to manage one's own family finances. The management aspect that it covers is helping the user to set up the financial targets they would like to achieve in life, estimating on how to go about in realizing it and track the daily spendings so that the user would stick to it. All of the information collected from the process above will be compiled and summarized so that the user can view it through easy to understand reports and graphs. In line with this, advices will also be generated to help the user along the way of better financial management.

The Waterfall Model with Prototyping approach was chosen as the project development methodology because the strengths of both the Waterfall Model and prototyping can be combined in a single project and reduces the risks involved. The development tool is that of the Rapid Application Development (RAD) type which is Microsoft Visual Basic 6.0 backed by Microsoft Access as the database management system. The Budget Advisor will be developed to sport a hybrid *Windows*/Web interface that is easy to navigate through, just like a web browser.

The report you are reading here is the final report submitted for the Budget Advisor project, developed during the course of "Projek Ilmiah Tahap Akhir I" and "Projek Ilmiah Tahap Akhir II". It shall give an introduction about the project, accompanied together with a literature review on materials researched and also cover the methodology used, system analysis, system design, the process I went about in system implementation and testing, the evaluation, final conclusion and finally the user manual for the Budget Advisor.

Acknowledgement

In conducting this project, I have identified many individuals who were kind enough to lend their support, . First and foremost, I would like to thank Puan Nazean Jomhari for her invaluable assistance, ideas and advices, all of which were crucial in contributing to the quality and time management of this project. Not to forget, Mr. Chiew Thiam Kian who is the moderator for this project, for sparing some of his time in reviewing the progress of this project and also giving a couple of suggestions on areas that may need improvements.

Also, many thanks go to the Central Bank of Malaysia (Bank Negara Malaysia) which has provided me with important resources from their catalog of publications. Their help was vital and form the basis for the groundwork of this project.

I would also like to convey my gratefulness to the individuals who had the time for participating in the questionnaire prepared. They play the part of determining the outlook of personal financial management use here in Malaysia and served to provide me with information in better designing the software.

Next, I would like to thank my fellow course mates whose suggestions are highly appreciated. One their names that I would like to mention is Nazuha, who I had shared and exchanged information with, contributing a lot in each other's projects along the way.

Last but certainly not least, this project is dedicated to both of my parents for their unending support through the years in my studies here in University of Malaya.

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Introduction

Chapter 1 Introduction

1.1 Project Definition

The aspect of financial management in our everyday lives rarely has been touched upon and most people normally would take it for granted when it comes to managing their money. This negligence will result in a great loss for themselves. A good financial management plan would help in assuring financial security for the individual, in which it would help a person to spend money more wisely and improve one's day-to-day finances. In the long run, this would help contribute to financial freedom and promise a better future for the individual. Be it the person is looking towards achieving a certain financial goal (buying a house, going for a vacation), saving it for the children's education or just aiming to secure a good life after retirement, financial management is the key [15].

This is where a personal financial management software comes in. The core application developed in this project, which is named as the Budget Advisor is a standalone (1 tier) personal financial management desktop application aimed at families who want to set certain financial goals in life, manage their finances with ease, track their spendings and achieve financial security. In short, it keeps their financial matters in check at all times. The software is tailored against the "Buku Perancangan Dan Penyata Kewangan Keluarga 2002" produced by Bank Negara Malaysia. The Budget Advisor hopes to provide the following features:-

- Present the user with a User Records page that helps to set up the user's personal details, financial goals, estimation of spending and allocation of expenses – in short, creating a personalized financial record which will be updated upon.
- Allows the user to enter information regarding their daily free spending transactions via the Daily Free Spending Input page and keep the records in a secured database.

- Generates a financial statement and various financial reports (in the form of a pie chart, line graphs and supplementary reports) for the financial goals planning, money inflow and outflow, the free spending allocations and also a track of the daily free spending; all intended for the user's viewing and lets the user to make comparisons based on classification. On top that, the documents viewed can also be printed on paper is the user wishes to.
- Categorizes the spending of the user according to the relevant common types of spending.

1.2 Project Motivation

"Kempen Galakan Menabung" is a campaign launched by the government of Malaysia to promote the habit of saving among its citizens. Together with this initiative, several books were published by Bank Negara Malaysia and distributed to the public in the aim to help them manage their personal finances. One of them is the previously mentioned "Buku Perancangan Dan Penyata Kewangan Keluarga 2002" which is targeted for the typical Malaysian family who wishes to better manage their finances.

The motivation for this project comes from the inclination of seeing the printed format of the book be translated into an easy to use application software. From my research, I have found that the easy to grasp step-by-step guidelines, financial tips and management techniques that were presented in the book would be best applied in a computer application which can be enhanced to include extra features such as automatic report tabulation, secure record safekeeping and attractive interactive graphical user interface.

An added factor that motivates the development of this project is the proliferation of computer use among Malaysians at the time being. Nowadays computers have become so much a part of life for almost everyone in which they use it daily to get through with their everyday lives. Furthermore, the Malaysian

government is aiming to place at least one PC in every household; schemes such as Odasaja and EPF withdrawals to buy computers illustrate this. Therefore, I find it wise that such a software which mirrors the features found in the book be built for the general public to use on their desktop PCs.

Lastly, at the time of this writing, there has not been any personal financial management software that was built to fit with the Malaysian financial system and if there were some already, most of them are custom built for the use of companies and therefore have not been made known for commercial use. This further motivates the need for one to be built according to the financial environment that the general Malaysians are well familiar with. Items relating to the situation in this country such as the Employees Provident Fund (EPF) and 'zakat' payment for the Muslims will hope to be included.

1.3 Project Objectives

The main objective of building the Budget Advisor system is to produce a comprehensive yet easy to use program that can be utilized by a typical Malaysian family interested in managing their finances. The program would allow associated transactions to be committed against the family's records, be updated from time to time and store them accordingly. From here, the gathered information will be used to generate various types of reports which will be broken down by category and would then let the user to make timely and accurate decisions. Additionally, the creation of the program also aims to:-

- use and apply the basic fundamentals in managing one's personal finance and free the user from the hassle of managing it.
- achieve the aforementioned objective through the use of a simple, user-friendly system and attract the first time user's attention immediately through guided assistance that would help the user to right away track his/her finances.
- study and investigate current techniques and skills that have not been made commercial and feature them in a formative and concise application software.
- continuously contribute to the user's financial interests by providing timely tips and advice.
- provide a professional financial management tool to cater to all types of users (from beginners to experts), mainly those residing in Malaysia and conforms to the financial situation in this country.
- reduce the clutter of space and perhaps time that it takes when dealing with paper documents.
- maintain the records of transactions performed by the user and calculate the forecasts of effects that may result in the future.

1.4 Project Scope And Limitations

1.4.1 Project Scope

The Budget Advisor application is a stand-alone application which covers the personal financial management of individuals with families in Malaysia. The potential users would then be these people who wishes to utilize a software application to manage their financial well being. This project will cover the following areas:-

- Customizes a distinguishable family record that collects information regarding the family's financial behaviour through an easy to follow wizard assistant.
- Allows transactions to be carried out at any time.
- Presents the user with summary reports and graphs in the form of spreadsheets, pie charts or line graphs.
- Provides appropriate advice to assist the user in making the right decisions.

1.4.2 Project Limitations

Nonetheless, just like anything else in this world, this project also has some limitations, which are:-

- It does not provide synchronization of information through the web as it is meant for use on stand alone (1 tier) PCs only. Therefore, it disallows the user from updating the family's records using a web browser from virtually any place that has web connectivity.
- The above limitation also makes it impossible for the user to automatically receive up-to-date and valuable tips in the field of personal financial management directly from the web.

- Reduced portability as it is meant for use on Windows-based PCs and therefore shies away from other different operating system platforms such as MacOS, Linux etc..

1.5 Target Audience

The target audience for this application is any person who is a member in a family, who wishes to track their family's expenses and budgeting through an easy to use software. This does not exclude even the youngest family member (for instance a 12 year old son) from using it, as it is developed to be as user-friendly as possible. In spite of this, I expect that the head of the family to be using it most of the time and manage the application. The target audience would also be the Malaysian citizen, as the Budget Advisor is tailored for use according to the financial situation in Malaysia. This feature differentiates it from other softwares (analyzed in Chapter 2 Literature Review) currently sold in the market, whose target audiences are mainly Americans.

1.6 Project Expected Outcome

The expected outcome from this project will be a stand-alone personal financial management desktop application that boasts the following characteristics:-

- **User Friendly** The user can instantly achieve his/her objective with the help of a trouble-free setup and call up for assistance in the form of the 'Financial Wizard' feature.
- **Well Documented** The user will be able to access the help guide and navigate or search through the contents for explanation on matters unclear to him/her.
- **Navigation** The interface will be designed to include navigation buttons (back, forward & home) as those available in most internet browsers and are familiar to the regular user for increased navigation capabilities.
- **Attractive** The interface will be designed to suit a professional look intended for home use and at the same time be attractive.
- **Integrity** The application will keep safe all of the user's transactions and records that will be updated upon plus track all the transactions entered by the user.
- **Low Use Of Resources** The application does not hog most of the system resources when it is in use ensuring added stability to the program. Plus, with this intent it is also hoped that it can be run on most computers with the minimum of requirements.
- **Effective Presentation** Presents the user with reports and graphs on various categories with the objective that presentation is handled in the most effective manner as possible.
- **Familiarization** To use a standard interface look across all of the pages the user navigates.
- **Helpful And Relevant Advice** To generate timely messages in aid for the user to make the best decisions.

1.7 Project Development Methodology

The waterfall model with prototyping is chosen as the development methodology for this project. This development life cycle consists of five phases, namely requirements analysis, design, coding, testing and documentation. The development life cycle for the Budget Advisor application is shown in Figure 1.1 below.

Through this methodology, the project initially enters the requirements analysis phase. Being the most important phase of all, the requirements of the software are analyzed and specified to ensure that they fulfill the needs of the user's requirements specifications. A requirement is a feature of the system or a description of something that the system is capable of doing in order to fulfill the system's purpose [21].

Next on is the design phase where the user's requirements are translated into a working solution; a design that will satisfy the user's needs. In this phase, the overall architecture of the software is devised and documented; this includes identifying the major components, what they are supposed to achieve and establishing the interfaces among the components. The coding phase is next where the design that was developed are implemented into a written program in the form of source codes that will be processed by the computer.

Once the program components have been coded, the project enters the testing phase in which we try to focus in finding faults in the program. Before releasing the software for use by the user, this phase is required to ensure that the software does what the requirements describe. Finally, the project enters the documentation phase where various forms of documents are prepared at each development phase to guide users in understanding the concepts and features relating to the program.

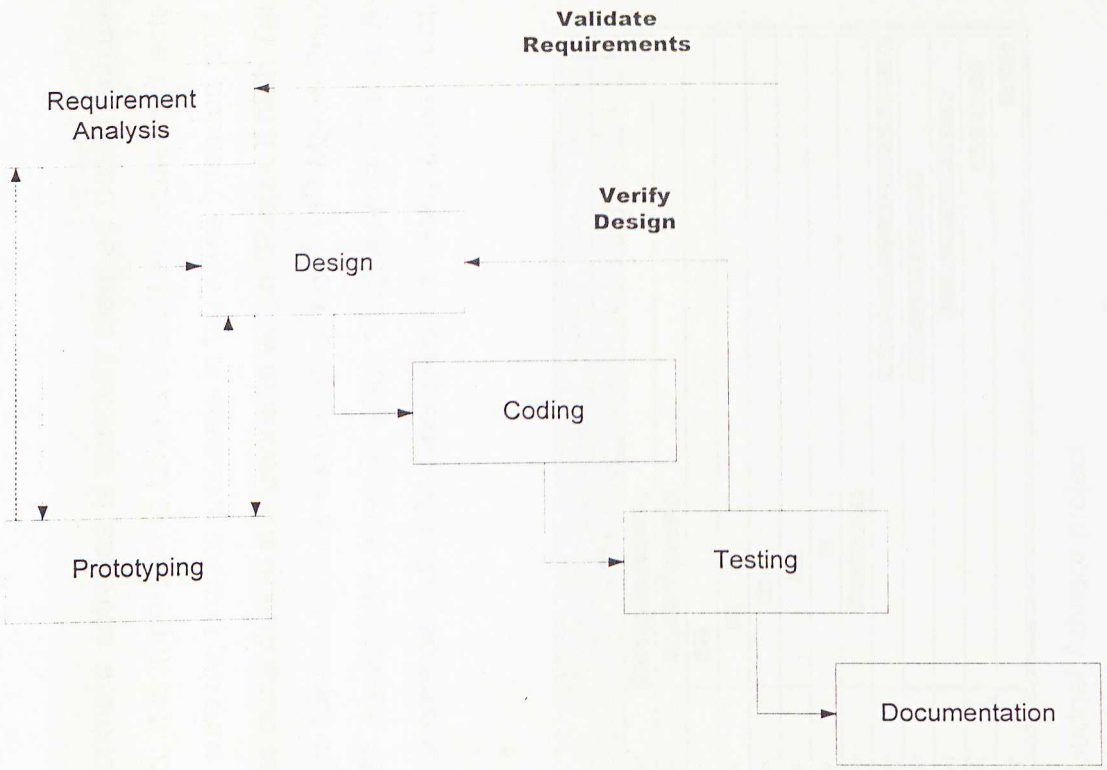

Figure 1.1 Project development methodology

1.8 Project Schedule

A project schedule that consists of the whole development activities is carefully planned out to achieve a systematic progress and ensure on-time delivery of the product. It is important to have a project schedule as it acts as a control and time management tool to the developer making sure the project proceeds in the route intended and the time constraint given. The proposal for the Budget Advisor was done during the period in which "Projek Ilmiah Tahap Akhir I" was taken; which constitutes the time space of 40 days (approximately two months) from 11th March 2002 to 3rd May 2002. The development of the project is resumed on 3rd June 2002, which is when "Projek Ilmiah Tahap Akhir II" was taken, ending on September 2002, in all amounting to a time period of 70 days (approximately three months). This is as shown in the project schedule in Figure 1.2 below.

ID	Task Name	Start	Finish	Duration
1	"Projek Ilmiah 1" Semester Khas	11/3/2002	3/5/2002	40d
2	Supervisor Consultation	18/3/2002	3/5/2002	35d
3	Resource Searching	18/3/2002	26/3/2002	7d
4	Literature Review	27/3/2002	2/4/2002	5d
5	System Analysis	3/4/2002	8/4/2002	4d
6	System Design	9/4/2002	16/4/2002	6d
7	Presentation	15/4/2002	19/4/2002	5d
8	Proposal Writing & Finalization	1/4/2002	3/5/2002	25d
9	"Projek Ilmiah 2" Semester 1	3/6/2002	6/9/2002	70d
10	Module Implementation (Coding and Testing)	3/6/2002	31/7/2002	43d
11	Supervisor Consultation	21/6/2002	22/8/2002	45d
12	System Testing	1/8/2002	30/8/2002	22d
13	Final Report Writing	19/8/2002	4/9/2002	13d

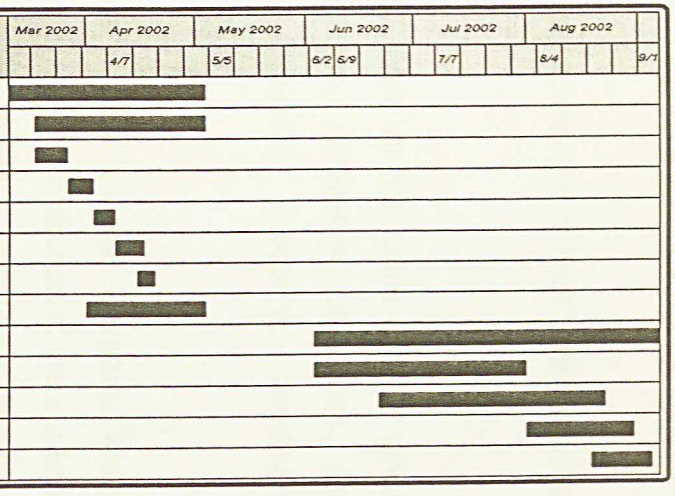

Figure 1.2 Schedule for the Budget Advisor project

1.9 Thesis Report Layout

This report is mainly divided into four chapters. A brief synopsis of each chapter is as follows:-

- **Chapter 1 : Introduction**
  This chapter serves as an introduction to the entire project where a clarification of the project's definition, motivation, objectives, scope, limitations, target audience, expected outcome, development methodology and schedule is given.
- **Chapter 2 : Literature Review**
  Literature Review consists of a review of the literature research undertaken which among others includes the definition of the application, a brief on the basis of the application, studies on existing softwares and also technologies that may be used to develop the application.
- **Chapter 3 : Methodology And System Analysis**
  This chapter further discusses the development methodology being used, requirements (non-functional and functional) analysis, hardware and software requirements plus considerations on the tools and technologies to develop the system.
- **Chapter 4 : System Design**
  System Design documents the various designs in implementing the system which among others includes the Data Flow Diagram (DFD), Entity-Relationship (ER) Diagram and an early look at the graphical user interface (GUI).
- **Chapter 5 : System Implementation And Testing**
  Covers the steps carried out during implementing the system, along with an explanation on the various levels of testing (unit testing, integration testing and system testing)
- **Chapter 6 : System Evaluation And Conclusion**

Problems that were encountered during the development of the project are highlighted here, along with listings of the system's strengths and limitations, and also suggested improvements on where the system might benefit in future revisions.

Chapter 2
Literature Review

Chapter 2 Literature Review

2.1 The Importance of Literature Review

A literature review in a project is important as it places the project in the context of others, which might resemble similar characteristics. It helps the developer such as myself to understand some of the existing features offered by a similar system.

"There is no use in reinventing the wheel that has already been invented" as the saying goes. Hence, this chapter would attempt to focus on learning the basis of the application (financial management), the basic features of other systems and would then try to modify, enhance and obtain inspiration for building a more powerful application in this project.

Development tools come with their advantages and disadvantages. This literature review also helps in equipping the developer with some knowledge of the strengths and limitations of several development tools. Therefore, it is hoped that the developer can then choose the right tools to develop the software.

2.2 Finding

The research in conducting the literature review is done through the following techniques:-

- Reading – the gathering of information through reference material was obtained from books in the UM library and from previous past year "Projek Ilmiah" documents from the FSKTM document room.
- Internet – current and up-to-date information regarding similar softwares that were developed were obtained through the web. From here, I was able to get differing reviews and opinions on the softwares I have chosen to be analyzed.

- Interviews – Interviews were conducted on a group of students and also a number of application developers regarding their thoughts on personal financial management softwares currently in the market today, and their suggestions on how a local version of such software should be created.

2.3 Personal Finance Management Overview

Money is one of humanity's oldest if not most reliable inventions. It supports the human need to buy, save and spend. This section would attempt to trace the subject of personal financial management as it is today.

2.3.1 General View

Personal finance management is not something that people usually educate, but most people are in the need of being educated in this subject matter. Financial intelligence is the mental process via which we solve our financial problems [23]. This being said, there are many books on educating the general public about personal finance. In the printed medium, we have publications (books, magazines and articles) produced locally to educate the local public; for instance Financial Freedom published by KL Mutual Unit Trusts and the bestselling Millionaires Are From A Different Planet written by Azizi Ali to name a few. They all offer sound advice and tips on managing money. The internet also offers such resources with the added service of counseling for the individual. One such example of the many available is the Money Management International website (http://www.moneymanagement.org/).

Though most people are fine following their methods in managing money, there are websites that cater to the need of individuals who would like to adopt a manager to track and plan their finances through the web. Several of them offer these services for free, though most of them charge a certain amount of fee to process the transactions. Among these sites are

'ihatefinancialplanning.com' (www.ihatefinancialplanning.com), Financial Passages Online (http://www.financialpassages.com.au/) and Norwich Union Personal Finance (http://www.norwichunion.com/). They all offer almost all of the same features found on current personal financial management software applications; the exception being that they require an internet browser in order to access the websites and the user's records are securely kept inside the website's database.

2.3.2 The Future of Personal Finance Management

The trend in finance nowadays is towards a cashless society. The twentieth century has seen a revolution in banking and the way in which we pay for our goods and services [16]. With added conveniences introduced in the world of money nowadays such as credit cards, automated teller machines, electronic banking and online banking on the internet, managing finances has never been so easier. The growth and improvements in application softwares developed to manage personal finances has also come to reflect the pace of financial technologies surrounding them in which we now see better integration to come into being.

For instance, **Microsoft Money 2002** lets its users to keep its Money file up to date with online banking where they can automatically download account transactions from the bank, and have them instantly recorded into the account register, saving time and effort. Other features in MS Money 2002 that exploit the use of internet are the bill payment services, synchronization of the Money file with MSN Money on the web and a side window that becomes a Web companion in giving instant access to accounts, investments, transactions and other key information in the Money file.

Not to be outdone by its rival, Intuit Inc. has also come out with a personal financial management software named **Quicken 2002 Home & Business** which also offers numerous features integrated to the internet. The

software simplifies money handling with the use of its One Step Update feature where the user can download transactions and account information (such as banking, credit card, brokerage or 401(k) balances and transactions) directly from the bank, credit union, credit card company or brokerage. Other services include paying bills, transferring money, downloading stock quotes and viewing selected Quicken data on Quicken.com.

It certainly looks like the future of personal financial management is heading towards the web integration employed by both of the application softwares mentioned above. There are several advantages from using such a software. Firstly, it serves as a bank branch on the desktop where users can communicate without having to go to the bank itself and at the same time keep safe a copy of their own finances in addition to those kept at the banks. As more and more financial institutions support the online access provided by these softwares (about 1400 supporting Quicken, 600 supporting Microsoft Money), it looks more likely that the many customers from different types of banks are going to adopt the use of these type of softwares. Secondly, it adds privacy for the user in which they can guarantee that their account information and passwords are stored only on their own computer and not in the cyberspace like most "account aggregator" websites that manage people's finances. Thirdly, it makes for a good portfolio management and goal-planning tools. With the user's accounts tied into these features, updation can be done on the portfolio values and the progress towards the financial goals in life can be checked regularly [2].

2.3.3 Present Problem Relating to The Situation In Malaysia

In Malaysia, we have yet to witness any integration between a personal financial management desktop application for use at home and the various companies managing our finances. As a matter of fact, to this very day such a software for the use of Malaysians have yet to exist. Although several companies in Malaysia have embraced the internet and set up websites to better serve their customers; such as the one by Maybank (www.maybank2u.com) launched on 9th June 2000 and Arab Malaysian Banking Group (www.ambg.com.my) which both offer online banking services, it is without saying that without the existence of a personal financial management software to use on the desktop, it may be far long before such an integration can be developed. Such an integration is important and might prove beneficial to the customers of various finance institutions in Malaysia, such as banking institutions, financial markets (i.e. the Kuala Lumpur Stock Exchange (KLSE)) and non-bank financial intermediaries (i.e. the Employee Provident Fund (EPF)).

2.4 Studies on Existing Softwares

This section would take a look at the current batch of latest personal financial management softwares that are available in the market today.

2.4.1 Analysis on Microsoft Money 2002

Software: Microsoft Money 2002
Manufacturer: Microsoft Corporation

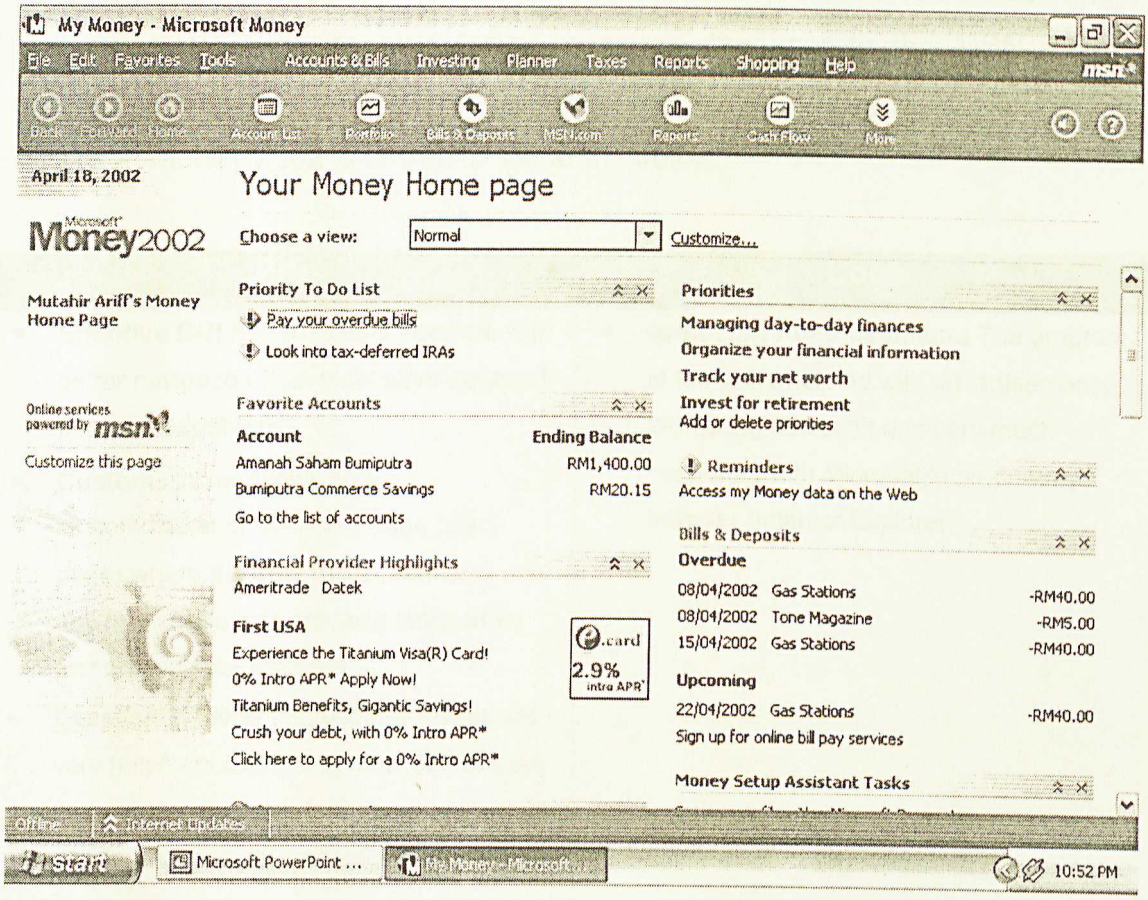

Figure 2.1 Screenshot of Microsoft Money 2002

Microsoft Money 2002 is one of the better personal finance software (if not the best) available in the market today having gone through ten version updates. The main business categories offered by the software include accounts list (banking and brokerage accounts), portfolio management (which deals with investments), bills and deposits (a listing of the items paid monthly) together with a cashflow track of the user's spending (dealing with the inflow and outflow of the user's money). Microsoft Money is really an extensive program as it also offers other categories optional for use by the user. These are the planners (lifetime, budget, debt reduction and a purchase wizard), taxes (estimator, deduction finder and manager) and shopping (which connects the user to the MSN eShop; shopping items include products, banking and brokers). The pros and cons of Microsoft Money 2002 is shown in Table 2.1 below.

Pros	Cons
• **Effective GUI** Better-looking interface with better navigation than most other personal financial assistants • **Customization** Allows better customization of the home page (start page) where the user most commonly will use to manage and prioritize tasks when first opening the program • **Excellent Videos** Instructional videos are very helpful in explaining most of the tasks that might be unclear to the user, attractive and familiarizes the user with the software • **Helpful Wizard Assistance** The Money Setup Assistant is very useful for the first time beginners to help personalize a Money file and the setup is a breeze and user-friendly	• **Annoying Advertisements** The program is too overwhelmed with advertisements promoting Microsoft and very much integrated with Microsoft's proprietary browser (Internet Explorer)

Table 2.1 Pros and cons of Microsoft Money 2002

Pros	Cons
• **Web Integration** Allows the user to automatically download and upload account transactions and information from and to the internet • **Allows Data Synchronization** Better synchronization with the internet through the MSN Money website (http://moneycentral.msn.com/home.asp)	

Table 2.1 Pros and cons of Microsoft Money 2002 (continued)

2.4.2 Analysis on Quicken 2002 Home & Business

Software: Quicken 2002 Home & Business
Manufacturer: Intuit Inc.

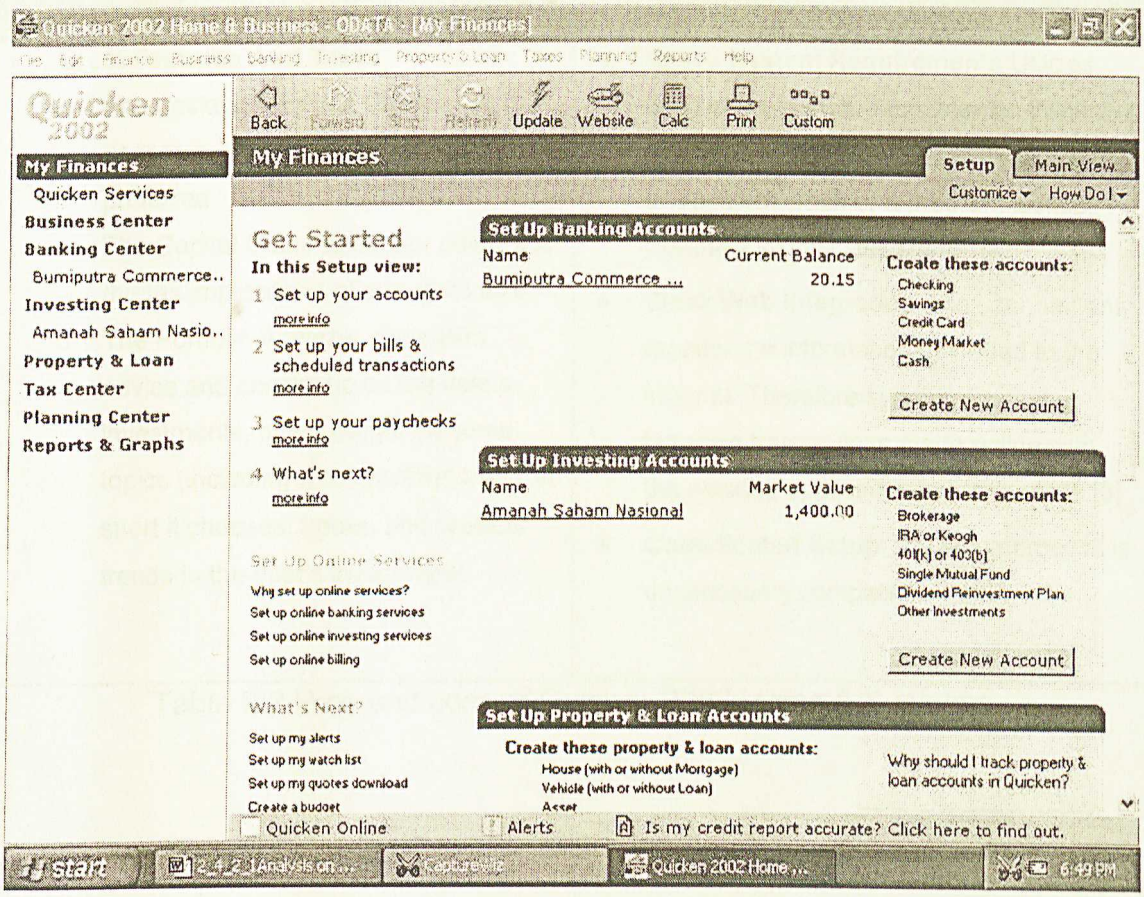

Figure 2.2 Screenshot of Quicken 2002 Home & Business

Quicken 2002 Home & Business is a software package catering both to the home and professional business user. The Quicken series of personal finance software was the premier and leading product to offer such service before other companies. Among the business categories offered are banking (to manage the user's bank accounts which ties with monthly bills and scheduled transactions), investing (offering a mini portfolio and alerts), property and loan (to deal with assets and liabilities for instance to buy a home or vehicle), tax (organize and store important tax records, view a tax projection using the provided tax calendar and find ways to reduce them) and planning (customizes assumptions about the user, manage upcoming events and develop a budget and savings target). The pros and cons of Quicken 2002 Home & Business is shown in Table 2.2 below.

Pros	Cons

• **Great Features And Tools**
  ○ The desktop Portfolio Tracker lets the user to sort the portfolio data as preferred
  ○ The Capital Gains Estimator points out the tax implications of any stock sale
  ○ The Portfolio Analyzer dispenses advice and checks up on the user's investments, offers insight on some topics (including stock performance); in short it chooses, tracks, and predicts trends in the user's investments
	• **Heavy System Requirements** Utilizes most of the system resources on Windows 95/98/Me based PCs which often results in a system crash or a program lockup; making it slightly less stable. [3]
	• **Weak Web Integration** The user can only monitor the information uploaded to the internet. Therefore synchronization between transactions made online with the desktop application is not possible [3]
	• **Complicated Setup** The setup process is unnecessary complex

Table 2.2 Pros and cons of Quicken 2002 Home & Business

Pros	Cons

• **Offers Web Integration**
  ○ Allows the user's portfolio to be uploaded on the Quicken website (http://www.quicken.com) so that it can be viewed from any PC
  ○ Allows transactions to be downloaded and synchronized from brokerages
• **Integration Among Products** Includes advanced investing and links seamlessly to the TurboTax tax preparation software (another product from Intuit Inc.) [3]
	• **Unavailable Further Assistance** Does not offer any wizards or instructions to guide the new user after the setup process is completed [3]
	• **Ineffective Graph Presentation** Many types of graphs are unavailable or hidden that the end result is that they are inoperable
	• **Unhelpful Prompts** Messages from program are ambiguous and unclear i.e. "Four messages were deleted" (Which four? How does the user finds them?)
	• **Poor Customer Service** Customer service is costly, poor and unhelpful [3]
	• **Interfering Advertisements** The program generates advertisements on the screen and pops up dialog boxes that tries to push other products

Table 2.2 Pros and cons of Quicken 2002 Home & Business (continued)

2.4.3 Analysis on Personal Financial Management

Software: Personal Financial Management
Manufacturer: Sofsource

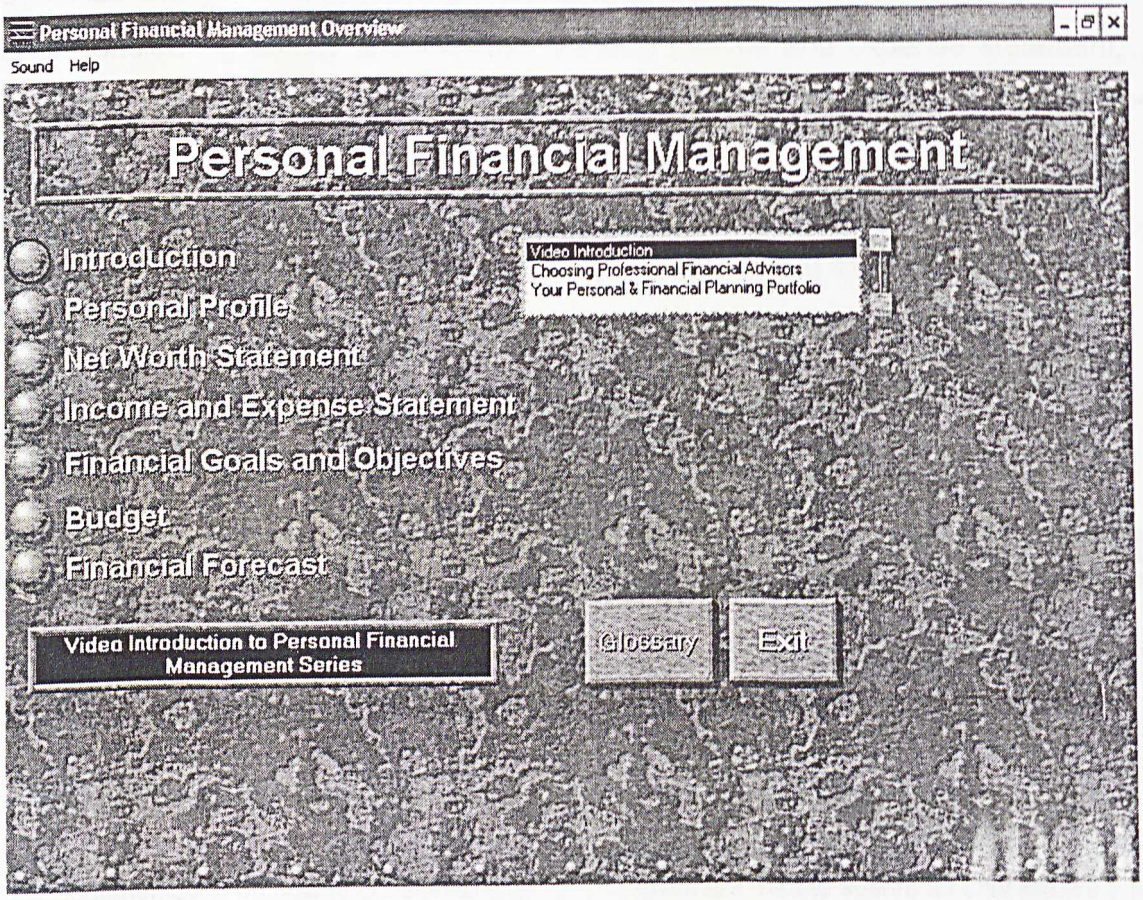

Figure 2.3 Screenshot of Personal Financial Management

The third software analyzed here is categorized as being different from the first two above as they are small in several areas including scope, the developer it originates from and the range of features offered. The basic business categories are net worth statement (the value of one's financial position after considering assets and liabilities owned), income and expense statement, financial goals and objectives, budget and financial forecast. The program works by collecting information from the user with the use of tabulated forms and the user would receive the information back organized in tabulated reports. The Personal Financial Management software is a program that does not really match up to its name, in the sense that most of the managing task are left for the user to perform. The pros and cons of Personal Financial Management is shown in Table 2.3 below

Pros	Cons
• **Effective Glossary Help** I have found that the glossary is among one of the easiest and effective to use. This is possible since the word array is not that many • **Simple To Use** Software is simple to use and does not require any external documentation on how to get started with it • **Low System Requirements** The requirements to run the software is not very demanding and can be run on most entry-level PCs that support Windows	• **Lengthy Explanations** Lengthy textual explanations makes the software less appealing to users who want to use the software immediately without having to read so much • **Ineffective Advice Presentation** The tips given are hard to absorb as they require too much reading and are presented in a manner that is not friendly to the user • **Hard To Understand Speech** The audio help (voice over) assistant's voice is that of an American accent, making it hard to understand. This suggests that the software is aimed for the American public

Table 2.3 Pros and cons of Personal Financial Management

Pros	Cons
	• **Unhelpful Videos** The provided video presentations are dull and boring which comprises of a person giving a lecture about personal money for the average length of 5 to 10 minutes • **Tedious Tasks** The task of entering financial information is repetitive and tedious, uses of extensive forms which extracts various unrelated information that may not be used for managing the user's personal finance • **Unattractive Interface** The software's user interface is not that easy on the eyes in that it employs dark colours and the use of awkward objects in designing the look of its surface • **Unavailable Wizard** No wizard assistant is present to guide the first time user at the start of the program

Table 2.3 Pros and cons of Personal Financial Management (continued)

2.4.4 Analysis on Financial Tools Deluxe

Software: Financial Tools Deluxe
Manufacturer: Vorton Technologies

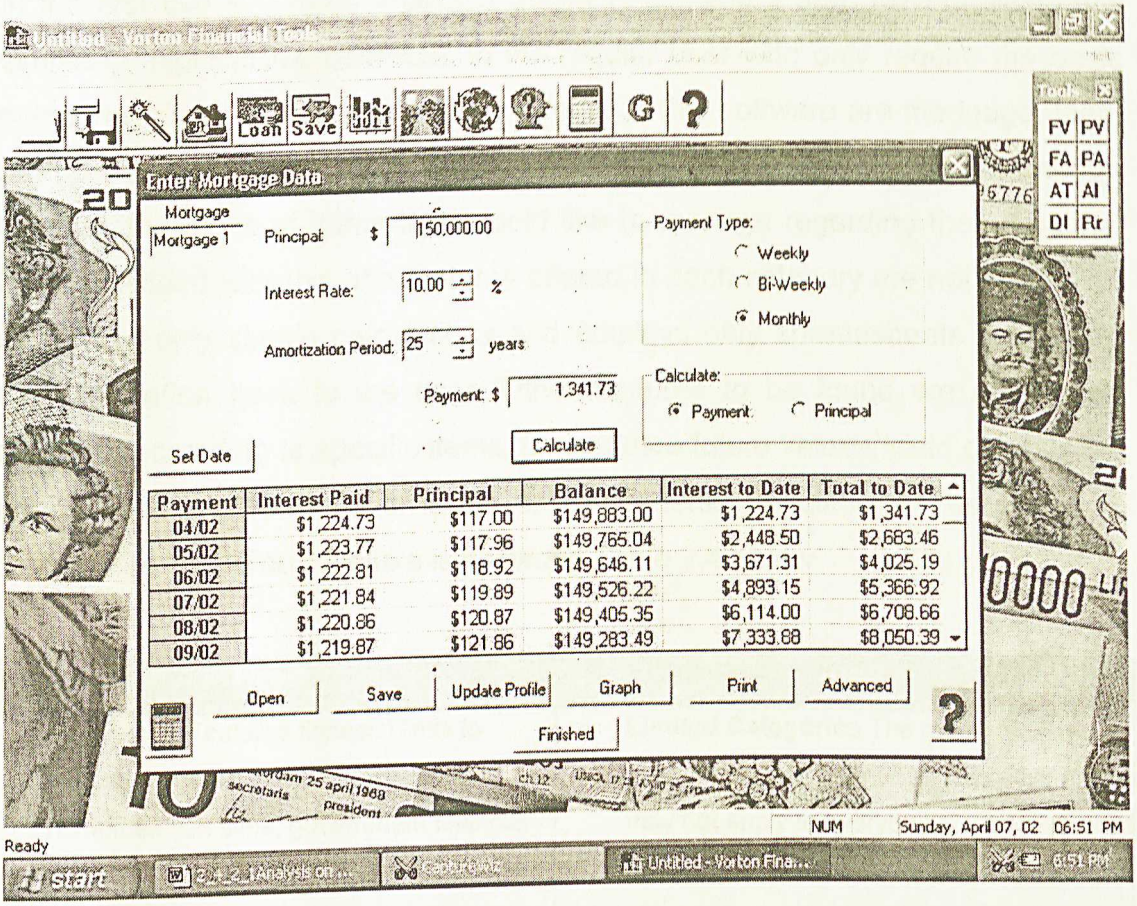

Figure 2.4 Screenshot of Financial Tools Deluxe

Financial Tools Deluxe is similar in category to the Personal Financial Management software above in that it was developed by a small company, does not offer web integration and the features are not as extensive as one might find in the first two softwares analyzed above (2.5.1 and 2.5.2). Nevertheless, this simplicity might prove beneficial to the regular user who only require the basic categories. The business categories offered in this software are mortgage, loan, savings, bond and retirement. Some users might find this to be adequate enough to cover the types of items they would like to manage regarding their personal finance. Added with this, the features offered in each category are not extensive, processes only simple calculations and employs only spreadsheets to present the information back to the user. Other features to be found are calculators designed according to specific items; for instance future values, yield on after tax and inflation and real rate of return on investments calculations. The pros and cons of Financial Tools Deluxe is shown in Table 2.4 below

Pros	Cons
• **Web Links** Features financial links to several websites of banks, investment resources, tax sites, government financial departments and the developer's website • **Wizard Assistant** Provides an easy to follow guide in determining the task the user wishes to do • **Simple Interface** The use of mainly icons to separate task options and prompted forms that collect information are friendly enough for the general user to figure out • **Low System Requirements** It can be run on almost any PC as the minimum processor required is as low as a 486 DX processor and memory requirement is only 8 MB	• **Limited Categories** The range of financial categories are inadequate, restrictive and may not apply to everyone • **Poor Customization** The user is not allowed further customization of the common tasks he/she performs to suit his/her financial situation • **Cluttered Interface Background** The background adopts a collage of various currency notes which I find to be uneasy to the eyes after some time • **No Report Or Graph Presentation** Information calculated is presented to the user in spreadsheet format which may prove quite ineffective compared to a report or graph presentation

Table 2.4 Pros and cons of Financial Tools Deluxe

2.4.5 Summary of Analysis

From the analysis, it is clear that most personal financial management softwares available were developed in America and targeted for use in the same country. Even though the business categories are extensive and varied, not to mention customizable, the fact that it does not familiarizes with the financial system in this country still stands. Besides, the financial advices offered from the respective integrated websites (MSN Money and Quicken.com) links to organizations that does business mainly in America and restricts their dealings from catering to users residing abroad.

Nonethelessm, the analysis still offers a great study and inspiration for contributing to the development of the Budget Advisor software in this project. The key advantage that the Budget Advisor would offer is it is tailored to suit with the Malaysian financial environment, and thus would attract Malaysians to use it. After conducting analysis on the four softwares above, I have identified the features in which the Budget Advisor could adopt to shape it into a good software:-

- **Hybrid *Windows*/Web Interface** The Budget Advisor should have a hybrid *Windows*/Web interface as the one seen in MS Money and Quicken. Such interface will use hyperlinks, hypertext and browser buttons in the hope of appealing to the many users familiar with a web browser and also to increase smooth navigation. Another advantage is that it allows implementation of custom menus based on information collected from the user. It is expected that this hybrid interface will become increasingly pervasive as businesses embrace the internet and intranets as the fundamental foundation for all information systems [24].
- **Question Answer Dialogue and Help Wizard** These features that are present in the first two softwares analyzed is effective for the more novice user where it guides the user through complex processes by presenting a sequence of dialogue boxes that require user input and

system feedback [24]. In addition to this, predefined options for easy selection and step-by-step confirmation are also present.

- **Extensive Business Categories** The Budget Advisor would try to suit with the Malaysian financial system and therefore offer business categories that relate to Malaysia, covering widespread items as possible.
- **Simple To Use** Taking into consideration the target audience which consists of the typical Malaysian family, the Budget Advisor will be designed to be of ease of use and minimize any learning curve whatsoever.
- **Low System Requirements** The Budget Advisor will try not to hog the system's resources resulting in a stable program that can be run on low power PCs supporting Windows, even those dating as far as 8 years back.

2.5 Converting Paper To Electronic

2.5.1 "Buku Perancangan Dan Penyata Kewangan Keluarga"

The Budget Advisor software is tailored from the "Buku Perancangan Dan Penyata Kewangan Keluarga 2002". The contents of the book was prepared with the help from financial institutions in Malaysia, representatives from the Jawatankuasa Kabinet Galakan Menabung, Jabatan Bekalan Air and Tenaga Nasional Berhad [18] and was also based on research done in Japan [12]. The production of this book is a follow up to the "Galakan Menabung" campaign launched on 16th December 1996 by the Malaysian government in efforts to increase the nation's reserves to speed up economic recovery. It has gone through several printings from year to year starting in 1999. The front cover of the book is as shown in Figure 2.5.

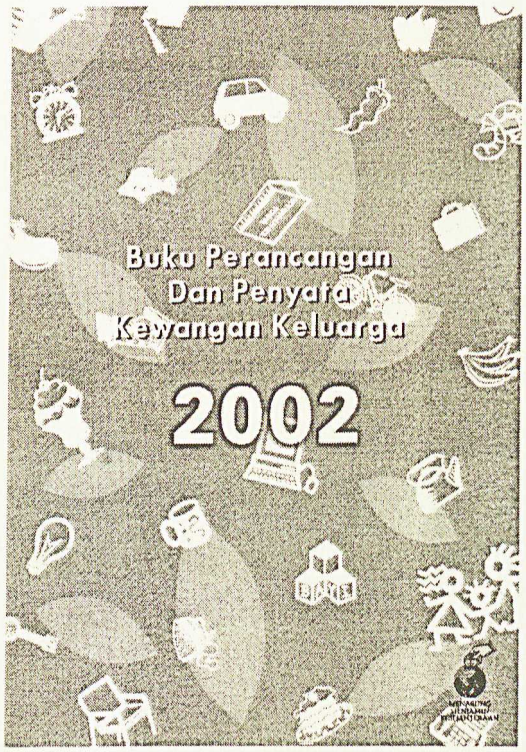

Figure 2.5 Front Cover of "Buku Perancangan Dan Penyata Kewangan Keluarga 2002"

The book was produced from the realization that a family's needs continues to increase whilst the income stays the same. Even so, a comfortable life can still be achieved through financial management and planned spending. Therefore, this book offers a simple guide to accomplish all of this. Included in the book are tips on saving water and electricity plus a calendar to jot important reminders regarding spending. The "Buku Perancangan Dan Penyata Kewangan Keluarga 2002" aims to achieve the following objectives:-

- Offer information and awareness on the family's daily spending pattern
- Enable the family to plan and make budget estimations.
- Enable the family to review the daily spending and spend wiser in the future.
- Produce a potential saving through reduction in electricity, water, telephone, clothes, entertainment, food, holidays and such.

2.6 Software And Technologies

This section looks at various software and technologies, that would help in developing the Budget Advisor.

2.6.1 Operating System

2.6.1.1 UNIX

UNIX is one of the most popular operating systems in the world, originally developed by Ken Thompson, Dennis Ritchie and others at AT&T. UNIX was originally designed to be a multitasking and multiuser system back in the 1970s, running on mainframes and minicomputers. With UNIX, each user logs in using a login name, and optionally the user must also supply a password. UNIX will run on just about every platform made. Many vendors (IBM, Hewlett Packard, Sun etc.) purchased the source code and have developed their own versions, adding special touches over the years. It was also given out freely to colleges and universities, including the University of California at Berkeley and Massachusetts Institute of Technology, which have been on the edge of development since the beginning. This wide-ranging distribution resulted in the lack of central standardization. Later on, standards started to appear, many falling under the IEEE POSIX.1 standard.

Under UNIX, for users to identify themselves with the system, they must log in, which entails two steps: Entering user's login name (the name by which the system identifies you) and entering his/her password, which is the user personal secret key to logging in to his/her account. No one else can log in to the system under his/her username without knowing the password. In addition, each UNIX system has a hostname assigned to it. It is this hostname that gives the machine a name, character, class and charm. The hostname is used to identify individual machines in a network, but even if the machine is not networked, it should have a hostname. The downside of UNIX is it is big (requiring 500 MB or more) and also expensive for a PC version of operating system [26].

2.6.1.2 Linux

Linux is a free; UNIX work-alike designed for Intel processors on PC architecture machines. Linux is not UNIX, as UNIX is a copyrighted piece of software that demands license fees when any part of its source code is used. Linux was written from scratch to avoid license fees entirely, although the operation of the Linux operating system is based entirely on UNIX and it shares UNIX's command set. It was designed to provide personal computer users a free or very low-cost operating system comparable to traditional and usually more expensive UNIX systems.

Linux can be run on as little as 150MB of space and as little as 2MB of RAM. Adding to these requirements, Linux is able to offer support full multitasking (multiple tasks can be accomplished and multiple devices can be accessed at the same time), virtual memory (utilizing all of the system's memory and does not allow memory segmentation to occur), the X Window System (a graphics system for UNIX machines, able to support many applications and is the standard interface for the industry), built-in networking support (standard TCP/IP protocols including Network File System (NFS) and Network Information Service (NIS)), shared libraries (each application saves a lot of hard drive space through a shared common library of subroutines that can be called at runtime) and compatibility with IEEE POSIX.1 standard (supporting many of the standards set forth for all UNIX systems).

Other advantages of Linux are its nonproprietary source code (abling other organizations such as commercial companies, hackers and programmers worldwide to develop software for Linux), it costs lower than most other operating systems (as a matter of fact it can be downloaded for free) and its Free Software Foundation's GNU project support (offering a wide range of free software from application development (GNU C and GNU C++), system administration (`gawk`, `gruff` and so on) and games (GNU Chess, GNUGo and NetHack) [26].

2.6.1.3 Windows Series of Operating Systems

This Windows series of operating systems mentioned here would cover the versions of Windows that are in use by most Intel based desktop computers. This includes Microsoft Windows 95/98/ME, Microsoft Windows 2000/NT4 and Microsoft Windows XP. The Windows family can be separated into two versions; the Windows 9x series (95/98/ME) and Windows NT (New Technology). This separation is mainly from the perspective of the types of environment it caters to (home and servers & businesses respectively) and the file systems (FAT 32 and NT file system respectively). The Windows 9x series is loaded with features designed for the general home user, offers the best in digital media, accessible to many, supports home networking and allows a rich internet experience. With Windows 2000 (also called Windows NT 5), Microsoft aimed to merge these two versions, which failed due to memory protection problems. Windows Millennium Edition (ME) emerged not long after to correct this problem, and after that its latest release, Windows XP [10].

2.6.2 Rapid Application Development (RAD) Tool

Rapid Application Development (RAD) is a programming system that enables programmers to quickly build working programs. In general, RAD systems provide a number of tools to help build GUIs that would normally take a large development effort.

Historically, RAD systems emphasizes on reducing development time, sometimes at the expense of generating efficient executable codes. Nowadays though, many RAD systems produce extremely fast executing codes. Conversely, many traditional programming environments now come with a number of visual tools to aid development. Therefore, the time between RAD systems and other development environments has become blurred.

2.6.2.1 Microsoft Visual Basic 6.0

Visual Basic (VB) is a fourth-generation language for designing and building applications with graphical user interface (GUI). It has proved to be a very popular tool for prototyping and constructing GUI and one of the easiest to learn. It provides a visual development environment for layouts of the user interface of an application. All components of the development environment are well integrated. It follows an event-driven programming model.

Visual Basic is a programming language and programming environment developed by Microsoft. Based on the BASIC language, VB was one of the first products to provide a Graphical Programming Environment and a paint metaphor for developing user interfaces. Instead of worrying about syntax details, the VB programmer can add a substantial amount of code simply by dragging and dropping controls (buttons and dialog boxes) and then define their appearance and behavior.

Although not a true object-oriented programming language in the strictest sense, VB nevertheless has an object-oriented philosophy. It is sometimes called an event-driven language because each object can react to different events such as mouse clicks. Since its launch in 1990, the VB approach has become the norm for programming languages. These days, visual environments for many programming languages are available including C, C++, Pascal and Java [25].

2.6.2.2 Sybase Powerbuilder 6.0

Developed by Sybase Inc., Powerbuilder 6.0 s one of the top client/server application development environments. Powerbuilder supports all of the leading platforms including Windows 98, NT, UNIX and MacOS. It's integrated development environment makes it relatively easy to develop and deploy sophisticated client/server applications. Powerbuilder supports native access to Lotus Notes databases in addition to traditional SQL data sources.

2.6.2.3 Macromedia Dreamweaver Ultradev

Dreamweaver Ultradev supports ASP technology and can be run on top of the Windows 95/98, ME and NT Server platforms. It is an integrated development tool and environment specifically designed for developers who want to build sophisticated, dynamic web applications as opposed to non-programmers. Applications include those for corporate intranets, on the internet accessible by any browser and also standalone 1-tier applications. Dreamweaver Ultradev supports team-based development and fully inter-operates with Microsoft Front Page, a tool targeted at end users and designers. This enables teams consisting of developers and non-programmers to work together on web sites. It's integrated development environment combines the look and feel of Office 2000 with the functionality of JavaScript and VBScript. It is also an "active

document container" that supports Microsoft Excel, Microsoft Word and ActiveDoc files. Plus, Dreamweaver Ultradev includes the Microsoft Front Page HTML Editors and the client-side script wizard which will generate VBScript or JavaScript by drag-and-drop direct code editing. Nonetheless, it also has a couple of weaknesses in which the Database Designer will **only** work with SQL Server databases.

2.6.2.4 Microsoft Visual Interdev 6.0

Visual Interdev comes as part of the Microsoft suite of programming tools, Visual Studio, and it is a tool for designing dynamic web application. Instead of using a programming language to create dynamic content, Interdev creates Active Server Pages (ASPs), an emerging technology developed by Microsoft. ASPs can contain embedded script logic that executes on an IIS server. ASPs appear to be HTML, or standard web pages. But, they also have special tags and code created and inserted by Visual Interdev between the HTML.

Visual Interdev supports both client-side and server-side scripting. Scripts can be written in either Visual Basic Scripting (VBScript) or Microsoft JavaScript (JScript). A Script Wizard enables users to quickly generate scripts with a point-and-click interface. ActiveX controls and Java Applets can be embedded into pages as well as server-side components for ASPs.

In addition, Visual Interdev boasts strong links with SQL Server, which makes it very easy to set up databases combining ASP and SQL Server. It also provides several useful web-based tools which can check links, highlight the broken ones on the users websites and allow drag and drop of pages from one location to another. Visual Interdev ships with Open Database Connectivity (ODBC) drivers for Microsoft SQL Server, ORACLE and Microsoft Access (the Microsoft Jet database engine).

2.6.3 Database System

2.6.3.1 Data Access Paradigm

Getting data from a data source (database) is indirect and requires the use of a data access interface. Fortunately, there are several methods that can be used to achieve this. It is significant to choose a suitable data access interface as it can result in better performance, easier of programming steps and also programming flexibility.

Universal Data Access together with other database programming paradigms were developed by Microsoft to allow applications to access and manipulate data in database server or other data repositories through the use of OLE DB provider. OLE DB is a low-level object-based interface that introduces a universal data access paradigm. This paradigm is proprietary to the Windows platform only.

2.6.3.1.1 *ActiveX Data Objects (ADO)*

ADO is Microsoft's newest technology for working with information in relational and non-relational databases. (Relational database management systems manipulate information in tables, but not all data sources follow this model.) ADO does not completely replace the existing database technology of Data Access Objects (DAO), but instead extends DAO programming into new areas. It has been designed as the successor to DAO and RDO, and it has a similar object model. In ADO, programmable objects represent all the local and remote data sources available to the computer. ADO is based on Microsoft's latest data access paradigm called OLE DB, which has been specifically designed to provide access to a wide range of business data sources including traditional relational database tables, e-mail systems, graphic formats, Internet resources and so on. ADO requires less memory than DAO, so it is more suitable for networked computer systems that experience heavy traffic and high

transaction rates [25]. Figure 2.6 shows how ADO communicates with databases.

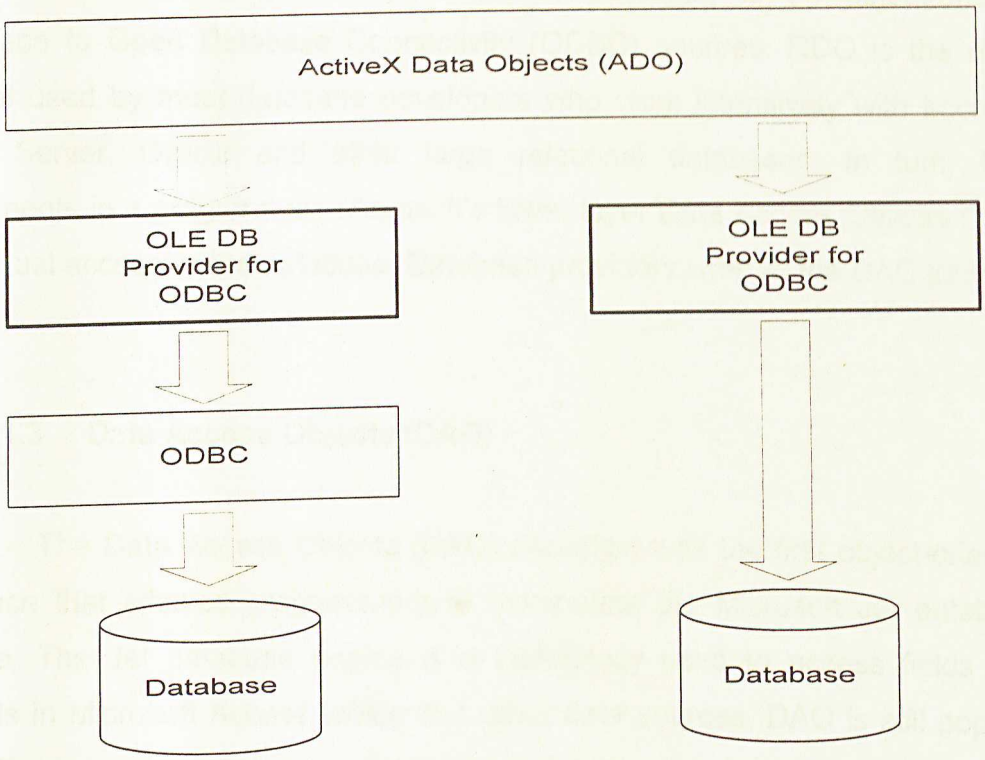

Figure 2.6 How ADO communicates with databases

2.6.3.1.2 Remote Data Objects (RDO)

The Remote Data Objects (RDO) paradigm is an object-oriented interface to Open Database Connectivity (ODBC) sources. RDO is the object model used by most database developers who work intensively with Microsoft SQL Server, Oracle and other large relational databases. In turn, RDO statements in a program use Microsoft's lower-layer Data Access Objects (DAO) for actual access to the database. Database providers write to the DAO interface [25].

2.6.3.1.3 Data Access Objects (DAO)

The Data Access Objects (DAO) paradigm was the first object-oriented interface that allowed programmers to manipulate the Microsoft Jet database engine. The Jet database engine is a technology used to access fields and records in Microsoft Access tables and other data sources. DAO is still popular and effective for single-system database applications and small to medium-size workgroup networks [25].

2.6.3.1.4 Open Database Connectivity (ODBC)

Open Database Connectivity (ODBC) is an open standard application-programming interface (API) for accessing a database. By using ODBC statements in a program, users can access files in a number of different databases, including Access, dBase, DB2, Excel and Text. In addition to the ODBC software, a separate module or driver is needed for each database to be accessed. The main proponent and supplier of ODBC programming support is Microsoft.

ODBC is based on and closely aligned with The Open Group standard Structured Query Language (SQL) Call-Level Interface. It allows programs to use

SQL requests that will access databases without having to know the proprietary interfaces to the databases. ODBC handles the SQL request and converts it into a request the individual database system understands [6].

2.6.3.2 Database Management System

2.6.3.2.1 Microsoft SQL Server

Microsoft SQL Server is a scalable, high performance database management system designed specially for distributed client/server application. It provides tight integration with Windows and Windows-based applications. Microsoft SQL Server is ideal for powering websites. Through tight integration with Internet Information Server (IIS), SQL Server can be queried and updated via popular web browsers (such as Internet Explorer or Netscape Navigator).

SQL Server provides agility to user's data management and analysis, allowing user's organization to adapt quickly and gracefully to derive competitive advantage in a fast-changing environment. It is also scalable as it will not only run on large, enterprise level NT Server systems or Windows 2000 operating systems, but it can also be run on a stand-alone (non-networked) laptop computer running the any of the Windows 95/98 family of operating systems.

Microsoft SQL Server version 7.0 is the most robust database to place on Windows, the Relational Database Management System (RDBMS) of choice for a broad-spectrum of corporate customers and Independent Software Vendors (ISVs) building business applications; in short the enterprise client/server computing. It also supports heterogeneous replication to non-SQL Server databases including Microsoft Access and ORACLE. SQL Server's replication uses ODBC as the connection mechanism [13].

2.6.3.2.2 Microsoft Access

Microsoft Access is a relational database management system created by Microsoft for small office or the home user for storing data in relational format. Together with data access paradigms such as Remote Data Objects (RDO) and Data Access Objects (DAO) (and recently, also ActiveX Data Objects (ADO) in the 2000 version), Microsoft Access can be used as a database in a client/server or an n-tier architecture system. It provides an intuitive and user-friendly interface to create a database easily. However, it is quite slow in processing transactions compared to Microsoft SQL Server.

Microsoft Access has become one of the most versatile applications in the Office suite (at the time of writing, it has entered its latest release named Office XP) evidenced by the rich set of tools that even the most experienced database user can take advantage of, while offering the same level of simplicity as the other Office applications for first-time database users. In short, it makes it easier for users to build and use their databases.

Access includes the new SQL Server 2000 Desktop Engine. This desktop engine is completely compatible with SQL Server 2000 and enables users to easily create and modify SQL Server-compatible databases. When ready, users can seemlessly deploy their database to a SQL Server 2000 without any modifications [13].

2.6.4 Graphic Software

2.6.4.1 Adobe Illustrator 10

Adobe Illustrator is the industry standard for creating professional quality vector graphics for web, print, PDAs, wireless devices and etc. Among the highlights included in this software are features that allow the user to balance image quality and file size, get an accurate on-screen view (with the use of its Pixel Preview and web-safe color picker), create complex graphics easily, add sophisticated color effects (such as solid, patterns and gradient fills) and utilize the great drawing tools (the industry standard pen tool and art brushes to paint artwork along an editable path). Its support for a wide range of file formats also makes it a feasible software to use. Finally, integration among other releases in the Adobe family of professional graphic programs (InDesign, GoLive, LiveMotion, After Effects and Premiere just to name a few) would be the best bet that a developer could get hold of [8].

2.6.4.2 Adobe Photoshop 6.0

Adobe PhotoShop is one of the most sophisticated and powerful image editing programs. It is used by more creative professionals around the world than any other image editing program. It provides the power to create compelling images and the precision to prepare them for the printed page, the Web and virtually any other medium.

Adobe Photoshop is the professional image-editing standard that helps its user to work more efficiently, explore new creative options and produce the highest quality images for print, the Web and anywhere else. The advantages are endless when one uses Adobe Photoshop; unlimited creative options (more than 95 effects filters in addition to the Liquify and Turbulence brush to distort images with precision), enhance photographs (powerful color correction tools and the sophisticated crop tool that corrects perspective as it crops) and create

compelling web graphics (produce instant GIF animations from layers, image maps, URL link and cascading style sheets (CSS)). The intuitive tools and advanced automation controls embedded in Photoshop lets work to be done at ease. Finally, just like Adobe Illustrator, Photoshop also provides the same tight integration among the professional graphic programs from Adobe [8].

2.6.4.3 Macromedia Flash MX

Macromedia Flash MX is the fastest way to create rich Internet content and applications with a better return on investment. Powerful video, multimedia and application development features allow the creation of rich user interfaces, online advertising, eLearning courses and enterprise application front-ends. Macromedia Flash is the key to designing and delivering low-bandwidth animations, presentations and websites. It offers scripting capabilities and server-side connectivity for creating engaging applications, web interfaces and training courses. Integration between Dreamweaver and Macromedia Flash enables users to easily integrate vector animations, MP3 audio and interactivity to produce high-impact, engaging web applications [9].

2.6.5 Reporting And Analysis Tool

2.6.5.1 Microsoft Excel

Microsoft Excel, the spreadsheet program, is included in the Microsoft Office package of softwares and at the time of this writing it has entered its latest 2002 release named Office XP. For many people, Microsoft Excel continues to be the technology on which they rely on a daily basis. Access is used mainly to access, analyze, share and display information with which they run their business in the accounting and finance departments. It centers around a spreadsheet in which the user can apply the tools provided in the software such as; the formula evaluator and auditing tools together with the Autosum tool, separated through

color-coded worksheet tabs. Excel version 2002 is designed to make it easy for anyone to share data with others, connect to important data on the Web or within an organization, and analyze that data to make better decisions.

The key use of Microsoft Excel in this project is its Chart Web Component that allows 3D charts to be constructed using the DirectX application programming interface and Office Art Fill Effects. The Chart Web Component has also added full support of the Excel PivotChart dynamic views features, plus new capabilities such as graphing multiple charts and data-driven conditional formatting. Finally, fully customizable drawing and layout controls enable users to create completely new chart types and custom annotations within their chart. Together with the connection directly to ActiveX Data Objects (ADO), this enables users to analyze data from data sources such as SQL Server or Microsoft Access [13].

2.6.5.2 Seagate Crystal Reports

Crystal Reports is the world's leading reporting tool providing flexible and powerful reporting technology to access information from a wide variety of data sources and create presentation quality reports. A powerful content creation software, it allows users to create a wide variety of report types (including subreports, conditional, summary, cross-tab, form, drill down, OLAP, Top N, multiple details, mailing labels) and at the same time being interactive. Powerful wizards, experts and built-in functionality help beginner and expert users quickly assemble highly interactive reports.

Customization of reports with logos, pictures, shapes and colors is also supported. An extensive formula language gives developers full control over report formatting, complex business logic and data selection. Crystal Reports also integrates with Microsoft Office applications such as Excel and Access. Report publishing to a variety of formats such as XML, PDF, DHTML, RTF, Word, Excel, text, email and the earlier Crystal Reports version 7. Among other

advantages of Crystal Reports is its high performance regarding report processing and comprehensive support for SQL database servers enabling faster report processing and better use of network resources.

Crystal reports offers unprecedented flexibility and control. The Report Designer Component (RDC) provides Visual Basic, C++ and other COM-based developers a powerful report server with a rich object model with complete control over report layout, formatting and behavior inside database applications [14].

Chapter 3 Methodology And System Analysis

Chapter 3 Methodology And System Analysis

3.1 Project Methodology

Effective development of a project depends on a thorough progress plan of the project. Thus, a plan must be drawn up to guide the development towards the project's goals. Furthermore, we can meet the deadline of the project without hesitation.

3.1.1 Waterfall Model With Prototyping

The development strategy used in this project is Waterfall Model With Prototyping which is a hybrid model combining the strengths of both the Waterfall model and prototyping. The waterfall model has been used to prescribe software development activities in a variety of contexts. Therefore, I find it appropriate to adopt it to serve as a base for the development of this project. Many other more complex models are embellishments of this model, incorporating feedback loops and extra activities [21]. The Waterfall Model With Prototyping is an example.

The Waterfall model presents a very high-level view of what goes on during development, and it suggests to developers the sequence of events they should expect to encounter. The software development process includes activities and subprocesses that can help enhance understanding. Prototyping is such a subprocess; a prototype is a partially developed product that enables customers and developers to examine some aspect of the proposed system and decide if it is suitable for the finished product [21]. The emphasis of prototyping is on trying out and experimenting with ideas, elicit and experiment with user interface requirements and usability factors as well as providing assumptions about requirements not on the system completeness.

Prototyping is involved during the early stages of the development where there is a high degree of uncertainty in several areas of the user's requirements

[20] as can be seen in Figure 3.1. This layout of the model has been refined to suit the project; this was shown earlier in Figure 1.1 (from Chapter 1 Introduction).

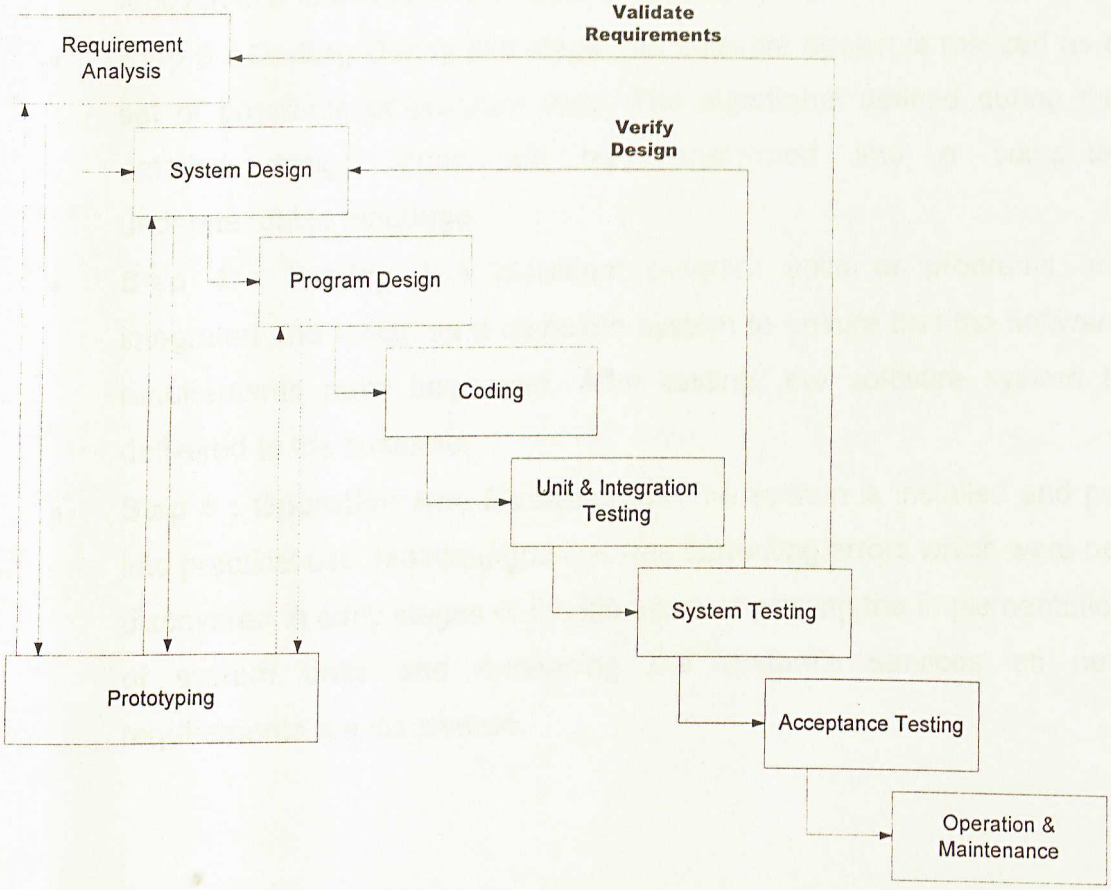

Figure 3.1 Waterfall Model with Prototyping

The principal stages of the model mapped onto the fundamental development activities are:

- **Step 1 : Requirements** The system's services and goals are established by consultation with system users. This stage analyzes the problem at hand and concludes with a complete specification of the desired external behaviour of the system to be built; also called functional description. Both users and development staff then define them in a manner which is understandable.

- **Step 2 : Design** The system design process partitions the requirements to either hardware or software systems. It establishes an overall system architecture. Software design involves representing the software system function in a form into one or more executable programs.
- **Step 3 : Coding** During this stage, the software design is realized as a set of programs or program units. The algorithms defined during the detailed design stage will be transformed into a computer understandable language.
- **Step 4 : Testing** The individual program units or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.
- **Step 5 : Operation And Maintenance** The system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in early stages of the life cycle, improving the implementation of system units and enhancing the system's services as new requirements are discovered.

3.2 System Analysis

System analysis is an essential phase in software life cycle that is used to determine clearly all of the necessary requirements before proceeding into subsequent phases. This procedure usually requires a few days time to complete for small-scale projects such as the Budget Advisor project. Even so, it can also last up to a few weeks time for large projects involving large amounts of money (banking systems), dealing with human life (patient intensive care systems) or the military (satellite defense systems).

The purposes of the system analysis phase are:-

- To acquire knowledge on how does a personal financial management software works.
- To study and understand the working of existing types of systems similar to the one in this project that have already been developed.
- To research on how the system in this project might be developed through current or the latest emerging technologies.
- To gain an overall understanding of and validate system data flow and system processes.
- To identify the software and hardware requirements for running the system.
- To analyze and place control features in order to achieve a robust and reliable system.

3.3 Requirements Analysis

A software requirement definition is an abstract description of the services which the system should provide and the constraints under which the system must operate [22]. There are two types of requirement analysis, functional requirement and non-functional requirement. The tasks for the requirements analysis phase of systems analysis is as shown in Figure 3.2 below.

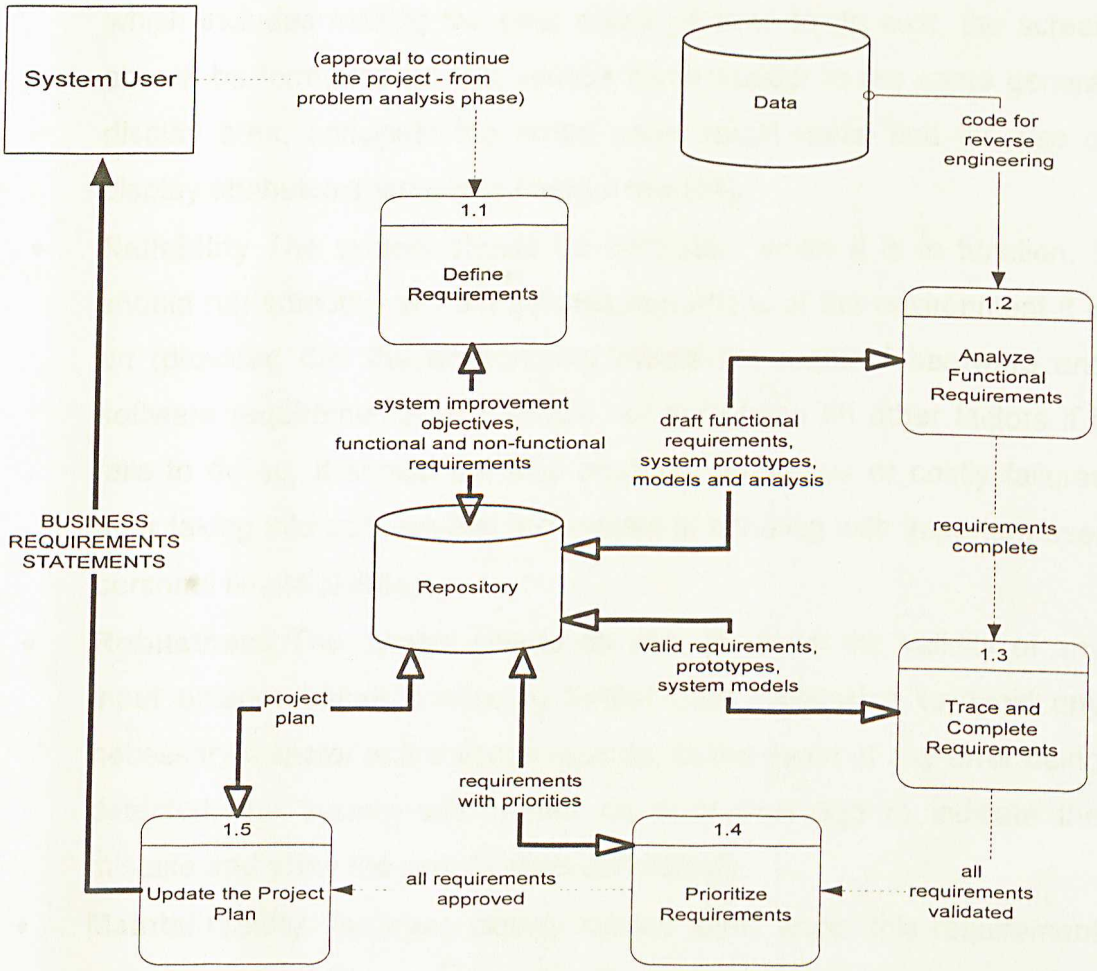

Figure 3.2 Tasks for the Requirements Analysis Phase of Systems Analysis

3.3.1 Non-Functional Requirements

Non-functional requirements define the features, characteristics and attributes of the system as well as any constraints that may limit the boundaries of the proposed solution. The non-functional requirements in the Budget Advisor software are as follows:-

- **User-friendliness** The system should have an interface that is user-friendly and capable of reducing any learning curves that the user might face. Human engineering factors will be incorporated into the design which includes making the user aware of what to do next, the screen should be formatted so that various items appear in the same general display area, anticipate the errors users might make and the use of display attributes sparingly to name a few [24].
- **Reliability** The system should be consistent when it is in function. It should run smoothly without glitches regardless of the environment it is on (provided that the environment meets the required hardware and software requirements) and should not put blame on other factors if it fails to do so. It should not also produce dangerous or costly failures after taking into concern that the system is handling with important user personal financial data.
- **Robustness** The system should be able to check the validity of any input entered before continuing further data processing to avoid any necessary disaster to the user's records. In the event of any error being detected, the system will prompt an error message to indicate the mistake and allow the user to react accordingly.
- **Maintainability** The three closely related items under this requirement which are testability, understandability and modifiability must be taken into consideration. These are among the most important contributors to full life cycle cost of software.

- **Response Time** All desirable information should be available to the users at any point of time. The requirement for timely information is also important.
- **Modularity** The system shall be developed with a modular approach at the very beginning to ease maintenance and facilitate scalability (modifications and enhancements) of any modules in the system in the future. The system is broken into sections or modules so that functions of objects could be distinct from one another. This characteristic eases the testing and maintenance.

3.3.2 Functional Requirements

Functional requirements state what the system should provide, how it should react to specific inputs and behave given a particular situation. In some cases, it also states what the system should not do. Functional requirements are independent from the implementation of the solution. There are four sections (parent modules) recognized as the most important functional requirements for this project; the Financial Plan Section, Reports And Charts Section, Advice Section and Help Section. As a supplement to express the functional requirements, refer to the UML transition diagram in Figure 3.3 below.

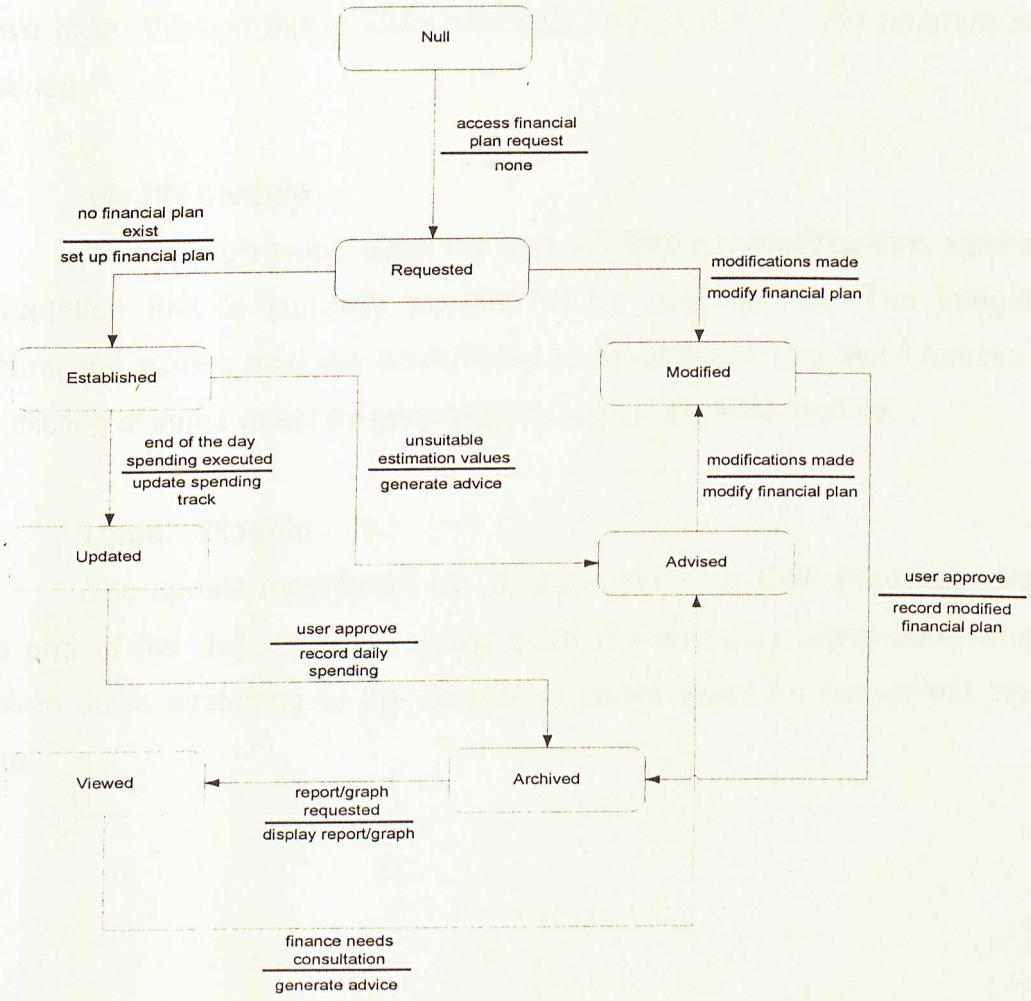

Figure 3.3 Transition diagram for Budget Advisor functional requirements

3.3.2.1 User Records Module

This component consists of several sub-modules relating to the sections that can be found in Budget Advisor; namely Parents, Children, Financial Goals, Money Inflow, Money Outflow and Free Spending Allocation. The sub-modules are Set Up, Modify and Update.

I. Set Up Module

This module is intended for customizing the user's personal details, place financial targets and make estimations on future spending. Setting up of the user records is done through the help of guided assistance. The user would have to go through this module only once, which is when the program is first opened.

II. Modify Module

This module would allow the user to make any modifications against the information that is currently present in the user records. The integrity of information across modules would have to be enforced and synchronized; any conflicting of sums would be generated through the advice module.

III. Update Module

The update module will be used to update the Daily Free Spending. At the end of the day, the user would enter the spending being done which is broken down according to the categories personalized for convenient input of data.

3.3.2.2 Reports And Charts Module

The information collected from the user records will be used to develop summary regarding the user's finance and generate various forms of reports and charts. This module will be linked with the Advice module, where the user can click on areas within the reports or charts to generate recommendations or tips suggested by the program.

I. Request Report or Graph Module

This module allows the user to view the reports (financial statements and summary of finances in a tabular format) and charts (similar with the reports with the option of changing the type of graph presentation; either pie charts, bar graphs or line graphs).

3.3.2.3 Advice Section

I. Request Advice Module

The user will have the option of requesting the advice separately or through the highlights identified when he/she views the reports or charts. On top of this, auto-generated advices will also be prompted against the information summed from the financial plans, consisting of suggestions from the program to balance the user's money allocation and estimations; the user will decide on what actions to take (whether to modify or not).. Based on different spending categories, percentages will be given on how much money each category should receive.

3.3.2.4 Help Section

I. Help Module

The help module would serve as an HTML-based electronic manual to guide the user on matters unclear, and would include a contents explorer, search and index option. It would offer the user with more information or assistance on how to complete a task, presenting a quick, easily accessible information to users who might otherwise have to leaf through a printed manual.

3.4 Hardware And Software Requirements

The following computer configuration was found to be the most suitable environment to deploy and have the Budget Advisor to run on. Table 3.1 shows the summary of hardware and software requirements considered for this project (note that requirements stated are that of the minimum necessary to be able to run the software).

	User Requirements
Hardware Requirements	• Intel Pentium 133 MHz (or any processor running on the same Intel chipset; AMD, Cyrix etc.) • 32MB RAM • approximately 100 MB hard disk space • Standard interface devices (mouse or similar compatible device, CD-ROM)
Software Requirements	• Microsoft Windows 95/98/ME, Microsoft Windows 2000/NT4 or Microsoft Windows XP

Table 3.1 Hardware and software requirements of Budget Advisor

3.5 Tools And Technologies Analysis

The knowledge acquired from the literature review presented in Chapter 2 was essential in determining the appropriate tools to be employed in developing the software. This section is divided to cover the considerations made on choosing the operating system, programming language, development tool, database management system (DBMS) and graphic software. The following were chosen after weighing the strengths and limitations of each.

3.5.1 Operating System Consideration

The Windows series of operating systems would have to be the best choice after taking into consideration of the target audience who will use the Budget Advisor. Most computers owned by the prospected users of this software are Wintel based (Windows on Intel based processors), plus the fact that many Malaysians are more familiar with the platform. Continued support of product updates to streamline with the rapid growth in technology from Microsoft on its Windows operating system assures the dominance of this platform for a long time to come.

3.5.2 Rapid Application Development (RAD) Tool Consideration

Having analyzed the various softwares in this category, Visual Basic has been chosen as the development environment where this project will be developed on. Macromedia Dreamweaver Ultradev and Microsoft Visual Interdev might have been good tools to work with, and certainly appeals to me, but both of them are apparently best for constructing dynamic web applications. Visual Basic controls allow users to add features to applications without having them involve with the details and is better suited to cater to applications such as the Budget Advisor. Visual Basic was chosen because of the following reasons:-

- It is one of the most popular development tools available on the Windows environment due to its Rapid Application Development (RAD) capability.
- Uses an event-driven approach to programming and is not a procedure language. An application developed with an event-driven model responds to events that happen in the computer environment. Such events include mouse clicks and function calls from another application running concurrently.
- To integrate everything seamlessly with the Microsoft Windows platform it is in, and the Microsoft Access database.
- Conforms to the project development methodology of "Waterfall Model With Prototyping" adopted for this project, as Visual Basic has been proven to be a very popular tool for prototyping.
- Support of the latest data access paradigms such as ADO, and at the same time optimizing its environment to make full use of the technology by offering features like ActiveX controls and scripting.

3.5.3 Database System Consideration

3.5.3.1 Data Access Paradigm Consideration

The newest technology from Microsoft, ActiveX Data Objects (ADO), is the best platform choice to develop the Budget Advisor on. The fact that it extends to the other existing data access paradigms and is similar in its object model illustrates why it was chosen. ActiveX controls is also widely developed and supported by third party organizations, making the prospect of scaling the software further in the future a trouble-free task. Whilst ADO is used here, it must said that Data Access Objects (DAO) database technology and OLE automation is also used extensively for development.

3.5.3.2 Database Management System (DBMS) Consideration

Microsoft Access 2000 will be the database management system of choice for a couple of reasons. Compared to SQL Server, it is slightly less in terms of scope, therefore appeals to users such as me, besides taking into account that the Budget Advisor is a stand-alone application and does not involve data transfers across networks. In addition, embedded minor SQL commands in Microsoft Access prove to be adequate enough to handle the small amount of user financial data. Plus, the construction of databases through intuitive GUIs simplifies the task.

3.5.4 Graphic Software Consideration

Adobe Illustrator 10.0 will be adopted as the graphic software for use in designing and editing the clip arts found all over the user interface. Its support of powerful image editing not to mention vector graphics such as clip arts makes it much more feasible to use compared to Adobe Photoshop . Illustrator is also more appealing because it combines Adobe Image Ready, which can be used together to create on-screen imagery and an interactive digital delivery for the Budget Advisor application. Automation of many of the tasks with the help of filters and effects are also factors on why it was chosen. Support from various publications and communities on the web for Illustrator is also extensive, thus encouraging the sharing of techniques and tips for using the software to the fullest. This makes accessing a large pool of Illustrator resources and clip arts a snap, a bonus when taking into consideration that this project will be developed in such a short time.

3.5.5 Reporting And Analysis Tool Consideration

Crystal Reports that was developed by Seagate (now known as Crystal Decisions) will be used to make possible the analysis and reporting functions offered by the Budget Advisor. Although Microsoft Excel might have been chosen because of its integration with other applications developed by Microsoft (specifically the ones that will be used to develop the system which are Visual Basic and the Windows operating system) and its commercial familiarity and popularity, it has been sidelined to make way for Crystal Reports that proved to be the better choice. Crystal Reports is on par with Excel in terms of the various integrations it offers (if not better). In addition to the powerful capabilities highlighted in Chapter 2 Literature Review, the software is easy to learn what with the assistants to guide you along the way; making for the reduction in the learning curve. No other choice would prove to be better than Crystal Reports, which has always been supported by Microsoft on its Visual Basic platform since its version 4.0 release.

Chapter 4
System Design

Chapter 4 System Design

4.1 Process Design

There were several design methodologies for the process design. This project is based on the data flow oriented-design methodology which is also called structured design. Data flow oriented-design stresses on modularity, top-down design and structured programming. Process design focuses on system structure design and data flow design.

4.1.1 System Structure Chart

Structure chart is used to depict high-level abstraction of a specified system. Structure charts also describes the interaction of independent modules. A structure chart is simply a diagram consisting of the modules and connecting arrows. The main program is divided into three major components; Financial Plan, Reports And Graphs and Advice. The system structure chart is as shown in Figure 4.1 on the next page.

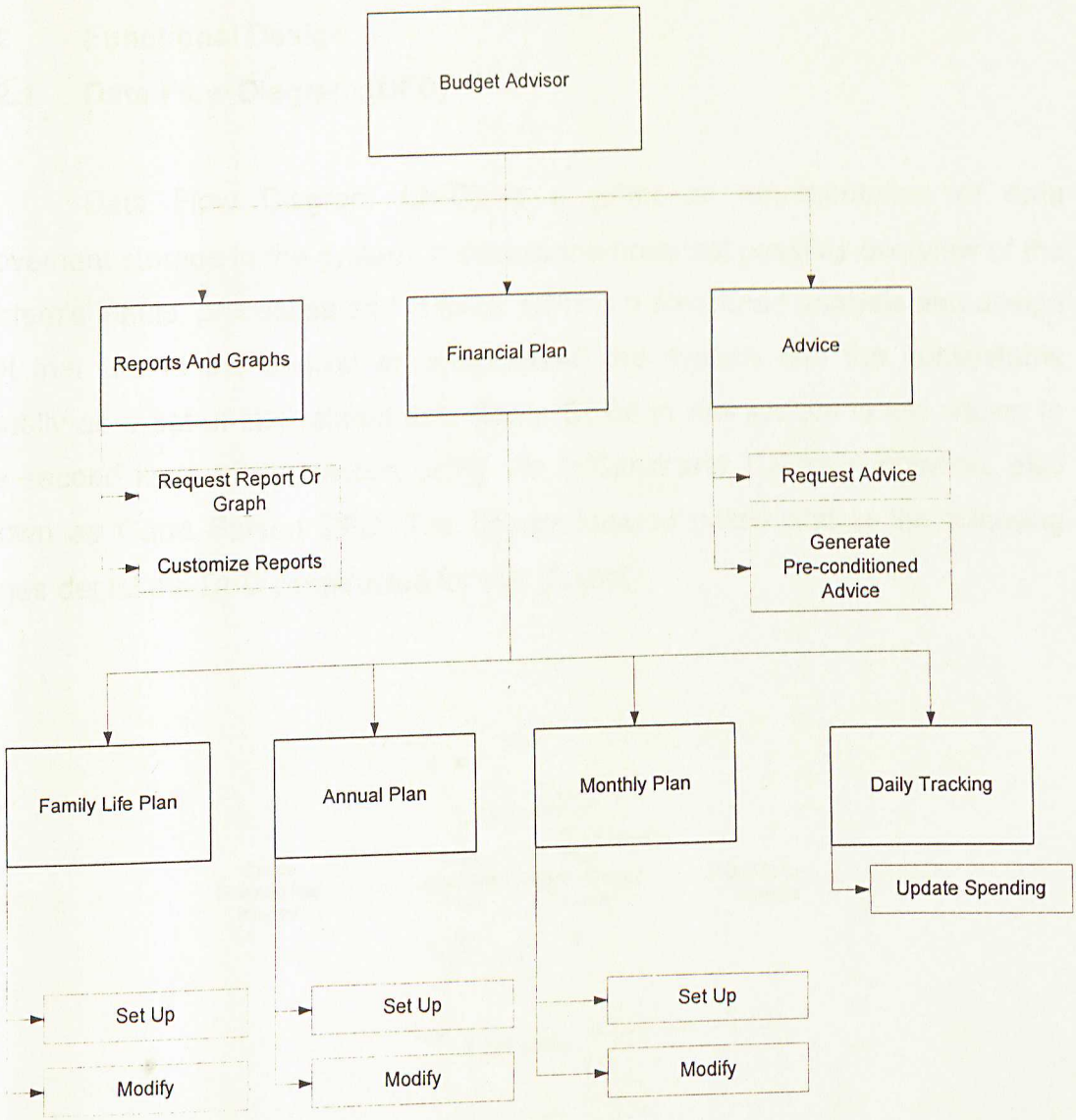

Figure 4.1 System Structure chart of Budget Advisor

4.2 Functional Design

4.2.1 Data Flow Diagram (DFD)

Data Flow Diagram (DFD) is a graphical representation of data movement storage in the system. It depicts the broadest possible overview of the system's inputs, processes and outputs. DFD is a structured analysis and design tool that allows the analyst to comprehend the system and the subsystems visually as a set of interrelated data flows. DFDs in this system is are shown to the second level of abstraction using the C.Gane and T.Sarson notation, also known as Gane Sarson DFD. The figures located below and in the following pages depict the DFD constructed for this project.

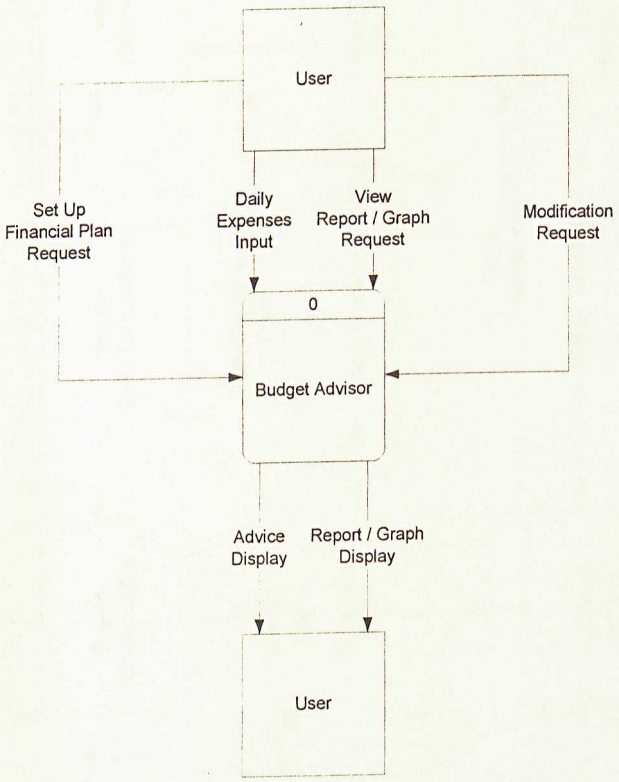

Figure 4.2 Context Diagram for the Budget Advisor software

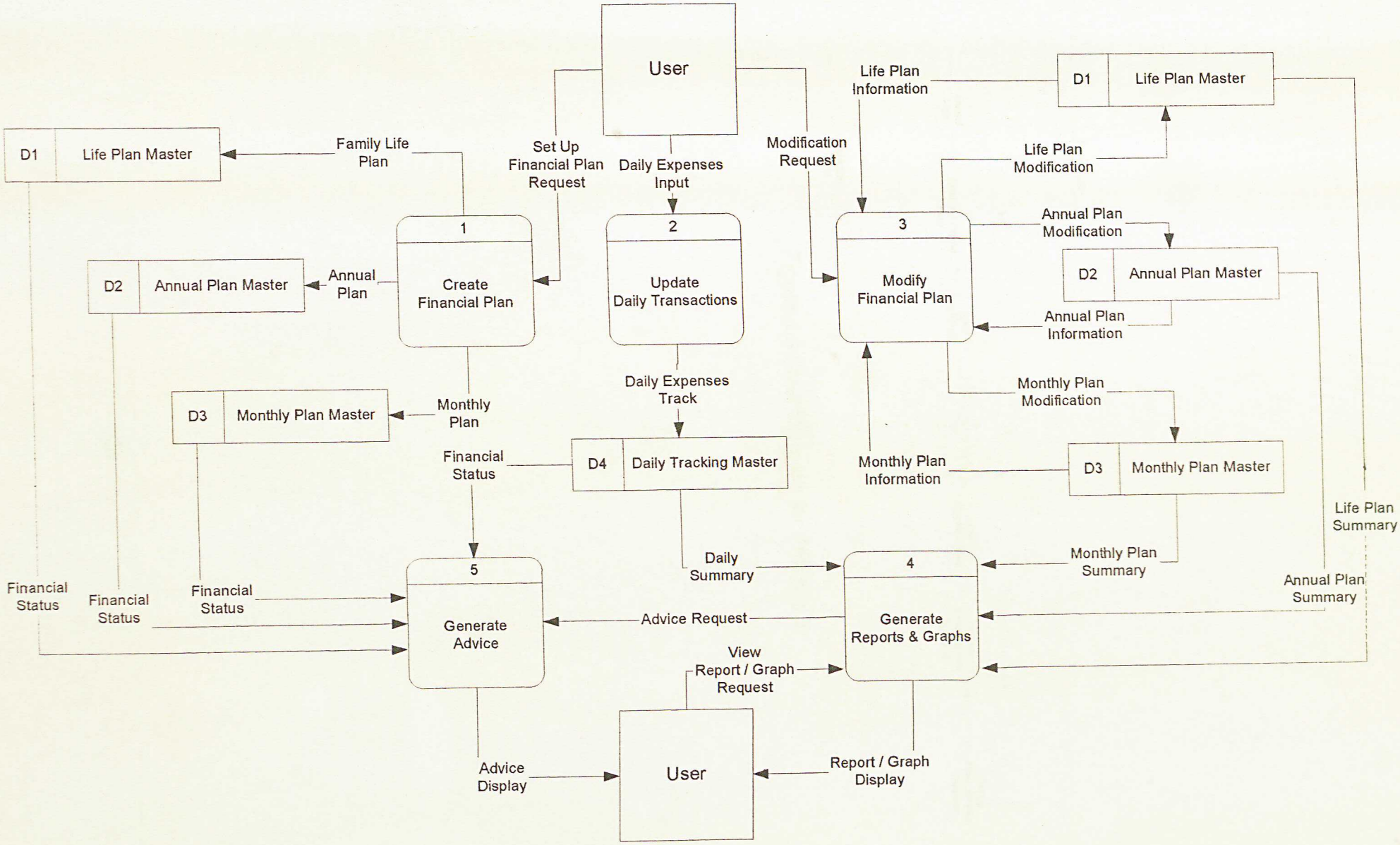

Figure 4.3 Diagram Level 0

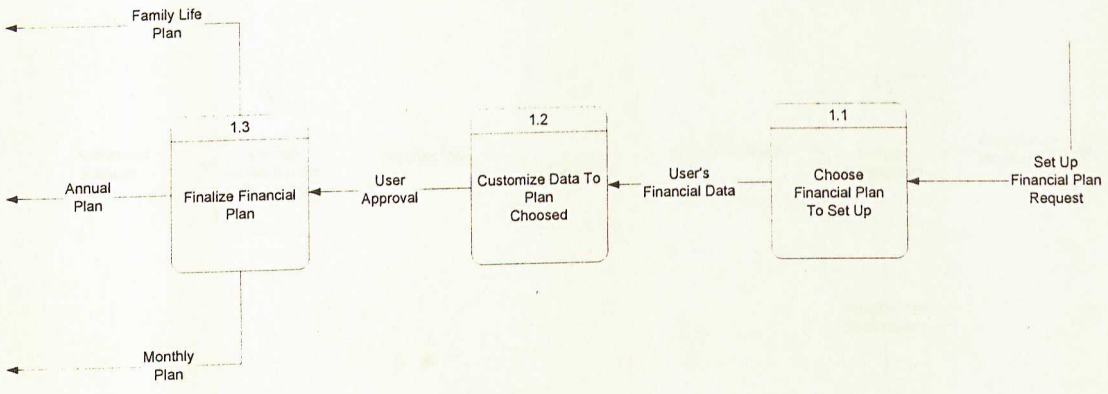

Figure 4.4 Child Diagram for Process 1

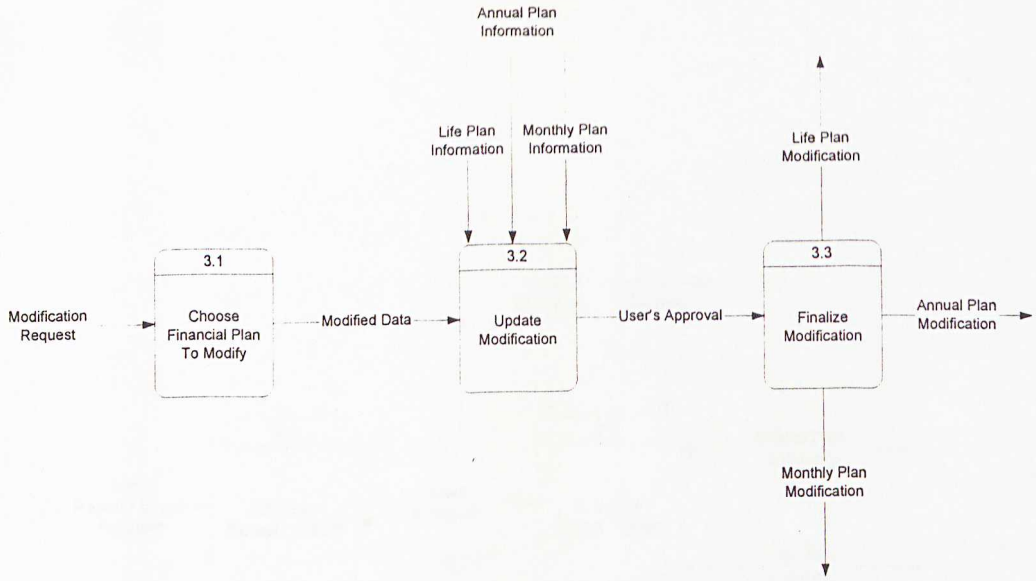

Figure 4.5 Child Diagram for Process 3

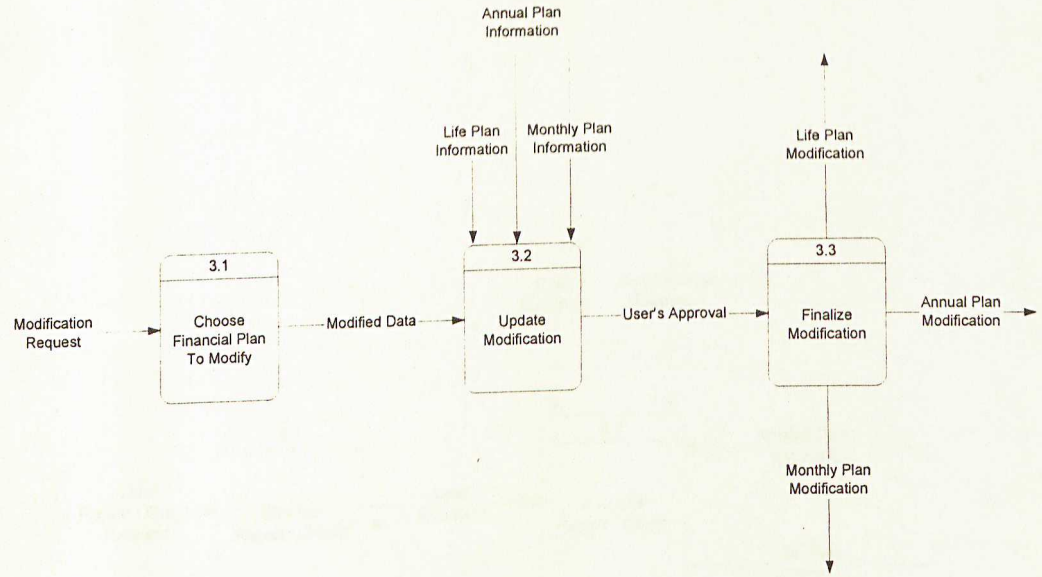

Figure 4.5 Child Diagram for Process 3

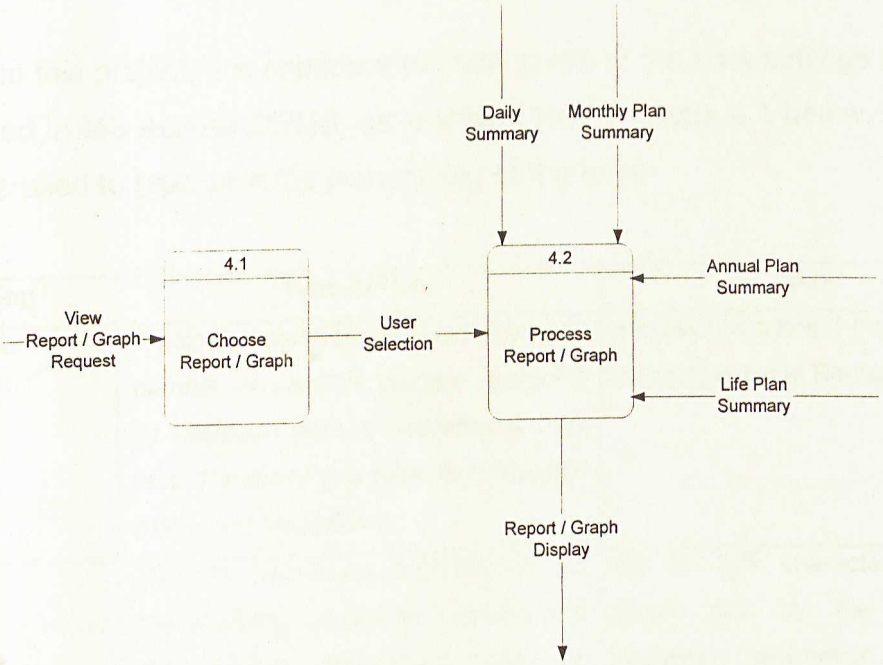

Figure 4.6 Child Diagram for Process 4

4.3 Database Design

The design of database is very important because it can greatly affect on the performance of data retrieval, updating and query in the run-time period of the system.

4.3.1 Data Dictionary

In this project, it is important to know some of the data settings and data types used in MS Access DBMS, as is shown here in Table 4.1 below. The "(*)" symbol is used to represent the primary key of the table.

Setting	Type of Data	Size
Autonumber	A unique sequential (incremented by 1) number or random number assigned by Microsoft Access whenever a new record is added to a table. AutoNumber fields can't be updated.	4 bytes (16 bytes if the FieldSize property is set to Replication ID).
Text	(Default) Text or combinations of text and numbers, as well as numbers that don't require calculations, such as phone numbers.	Up to 255 characters or the length set by the FieldSize property, whichever is less. Microsoft Access does not reserve space for unused portions of a text field.
Date/Time	Date and time values for the years 100 through 9999.	8 bytes.

Table 4.1 Desciption of data settings

Setting	Type of Data	Size
Currency	Currency values and numeric data used in mathematical calculations involving data with one to four decimal places. Accurate to 15 digits on the left side of the decimal separator and to 4 digits on the right side.	8 bytes.

Table 4.1 Desciption of data settings (cont'd)

Following are the data requirements for Budget Advisor, laid out in their respective tables.

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for parent entry
Position	Text	Parent's position in family (Head of Family or Spouse)
Name	Text	Name of parent
Age	Text	Age of parent
Birthdate	Date/Time	Birthdate of parent

Table 4.2 Parents

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for child entry
ChildName	Text	Name of child
Age	Text	Age of child
Birthdate	Date/Time	Birthdate of child

Table 4.3 Children

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for financial goal entry
FinancialGoal	Text	Name of financial goal
Date	Date/Time	Date expected to achieve the financial goal
Cost	Currency	Cost that it takes to achieve the financial goal

Table 4.4 FinancialGoals

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for money inflow entry
Frequency	Text	Frequency of money inflow (Monthly or Yearly)
SourceIncome	Text	Source of money inflow (name)
Amount	Currency	Amount of money inflow

Table 4.5 Inflow

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for money outflow entry
Frequency	Text	Frequency of money outflow (Monthly or Yearly)
OutflowType	Text	Type of money outflow (Saving or Expense)
OutflowName	Text	Name of money outflow
Amount	Currency	Amount of money outflow

Table 4.6 Outflow

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for free spending allocation entry
Frequency	Text	Frequency of free spending allocation (Monthly or Yearly)
FreeSpendName	Text	Name of free spending allocation
Amount	Currency	Amount of free spending allocation

Table 4.7 FreeSpend

Field Name	Setting	Description
ID (*)	Autonumber	Unique number for daily free spending entry
FreqCategory	Text	Frequency category of daily free spending (Monthly or Yearly)
Date	Date/Time	Date of daily free spending being done
FreeSpendName	Text	Name of daily free spending
Amount	Currency	Amount of daily free spending

Table 4.8 Daily

4.3.2 Entity-Relationship (ER) Diagram

The ER Model was introduced by Peter Chen in 1976 to facilitate database design. The main purpose for developing a high-level data model is to support a user's perception of the data. The diagrammatic representation of all tables in the database is illustrated in the ER diagram in Figure 4.7 on the next page.

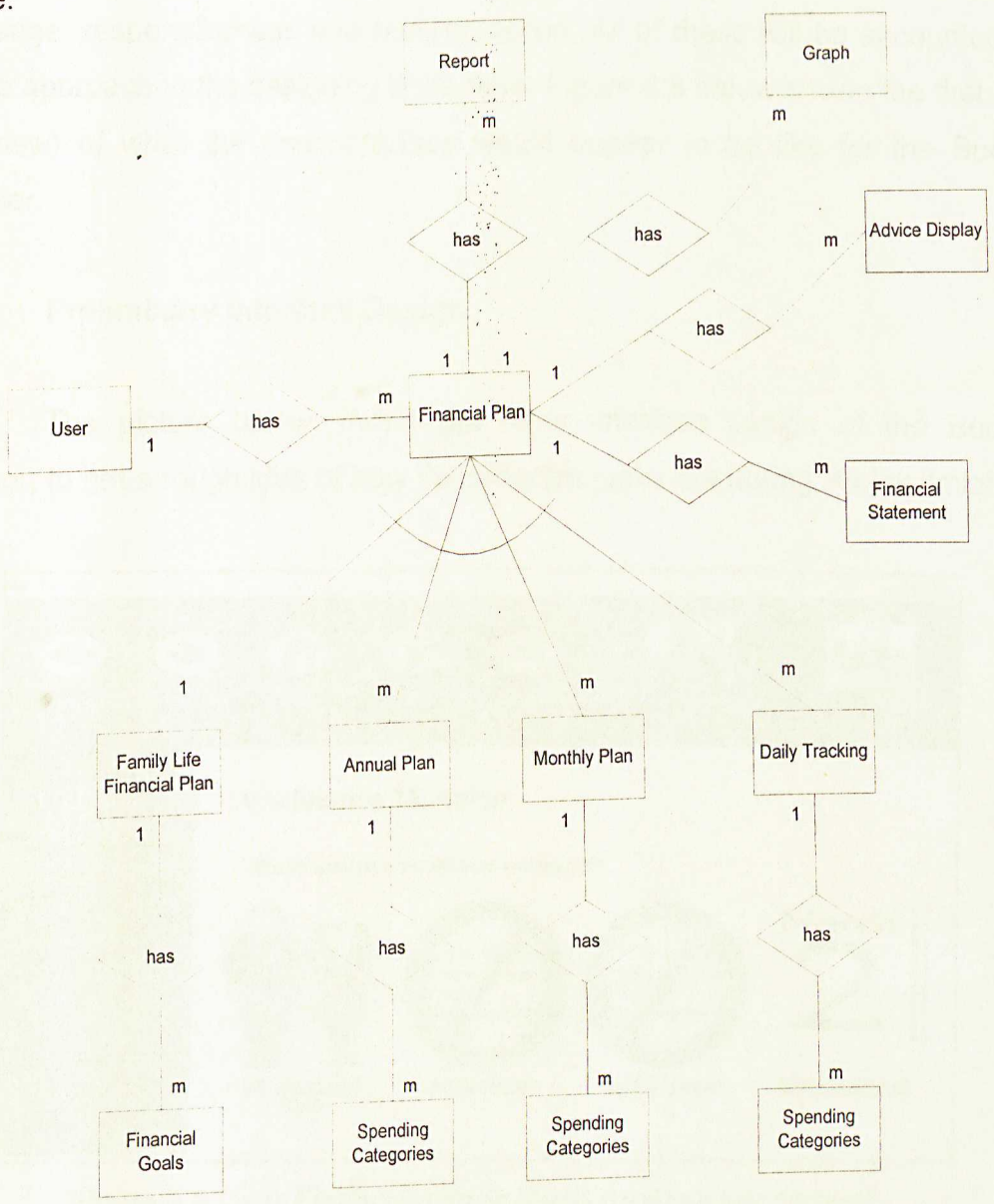

Figure 4.7 Entity Relationship Diagram of the Budget Advisor software

4.4 User Interface Design

User interface design is a very important factor determining the usability of an application. A good graphical user interface (GUI) should be intuitive, minimizes the need for the user to memorize things and at the same time is also interesting to look at. There are several general principles for user interface design, which are consistency, recoverability, confirmation and verification of message, responsiveness and reverse action. All of these will be accounted for to the approach in the designing done here. Figure 4.8 below shows the first look (preview) of what the user interface would appear to be like for the Budget Advisor.

4.4.1 Preliminary Interface Design

The picture below shows the early interface design of the Budget Advisor, to get a rough idea of how the program looks like during Projek Ilmiah 1.

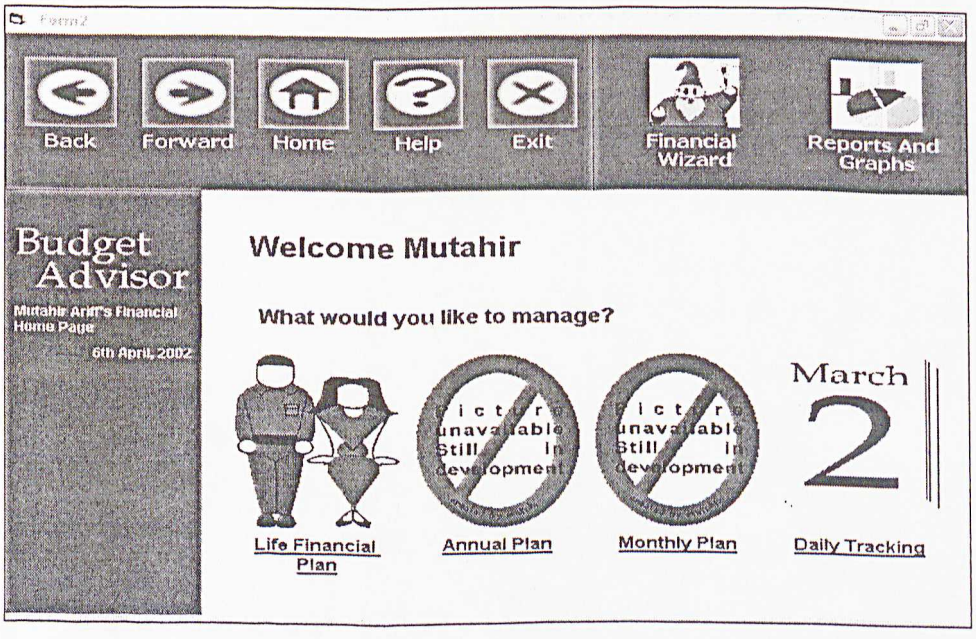

Figure 4.8 User Financial Home Page (preliminary design)

As can be seen, the interface layout resembles that of a web browser, a hybrid *Windows*/Web interface if you may. It is divided into four areas, explained below in a clockwise order:-

- **Top Left Area** where the Help button and navigation buttons (Back, Forward, Home and Exit) are located. The buttons will react to mouse cursor rollovers and also when it is clicked. This area will serve to help in user navigation through various parts of the program.
- **Top Right Area** where link buttons are provided for immediate links to the features that the user might regularly use from time to time. At the time, the features are the Financial Wizard Assistant and Reports & Graphs.
- **Bottom Right Area** where information contents from financial plan details, reports, graphs and statements etc. will be displayed. The look (background) will change corresponding to the user's choice, a different look for each of the financial plans and the home page.
- **Bottom Left Area** would present the user with a set of common tasks corresponding to the financial plan being selected.

4.4.2 Final Interface Design

As development of the program progressed, the interface design has been changed almost entirely. I have decided to omit the hybrid *Windows*/Web interface, and decided to go for a much simpler interface. Below is a look of the program when the user first opens it.

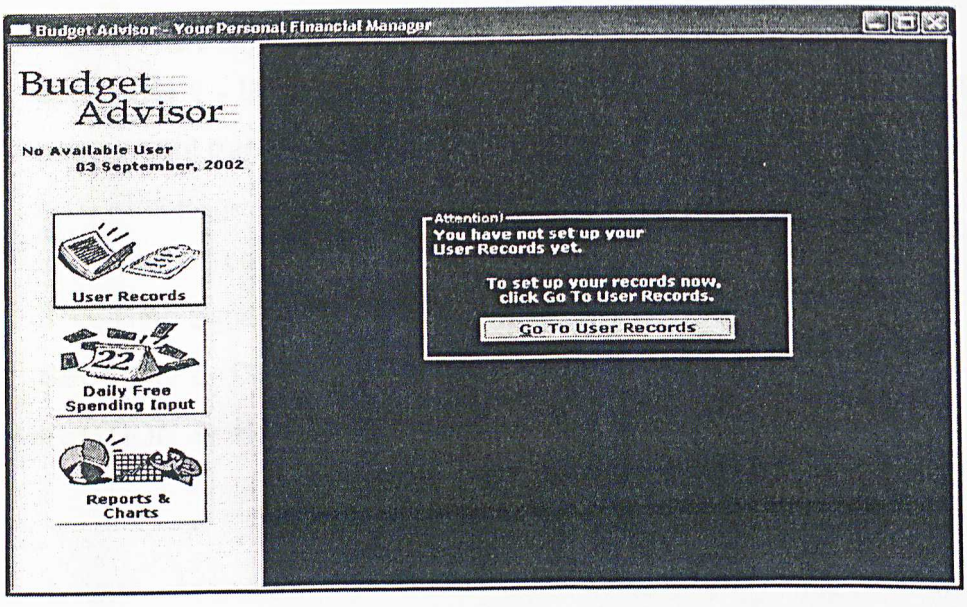

Figure 4.9 User Financial Home Page (final design)

As can be seen, the new and final interface is now simply divided into two areas, as explained below:

- **Left Pane** is where the buttons linked to the three sections will be located. At the top of this left pane is the Budget Advisor logo, followed by the name of family and the current date of the day. The three buttons that corresponds to the three sections are named (from the top) User Records, Daily Free Spending Input and Reports & Charts.
- **Right Content Area** where the content sensitive pages will be displayed the moment the user clicks any of the buttons on the left pane.

Upon opening the program for the first time, the user will be brought into attention that they have not set up their User Records yet. To start setting up their records, they would have to click the Go To User Records button, which would bring them to the screen below (this is also the same screen the user sees if the User Records button on the left pane is clicked). Please refer to Figure 4.9 above.

The sections are listed below. Refer to the figures (Figure 5.0, 5.1 and 5.2) in the following pages.

- **SECTION 1 - User Records**. Clicking Next would bring the user to the subsequent page, as listed in order below:-
  - First page - **Family Composition & Financial Goals**
  - Second page – **Money Inflow (+) & Money Outflow (-)**
  - Third page – **Free Spending Allocation**
- **SECTION 2 - Daily Free Spending Input**
- **SECTION 3 - Reports & Charts**

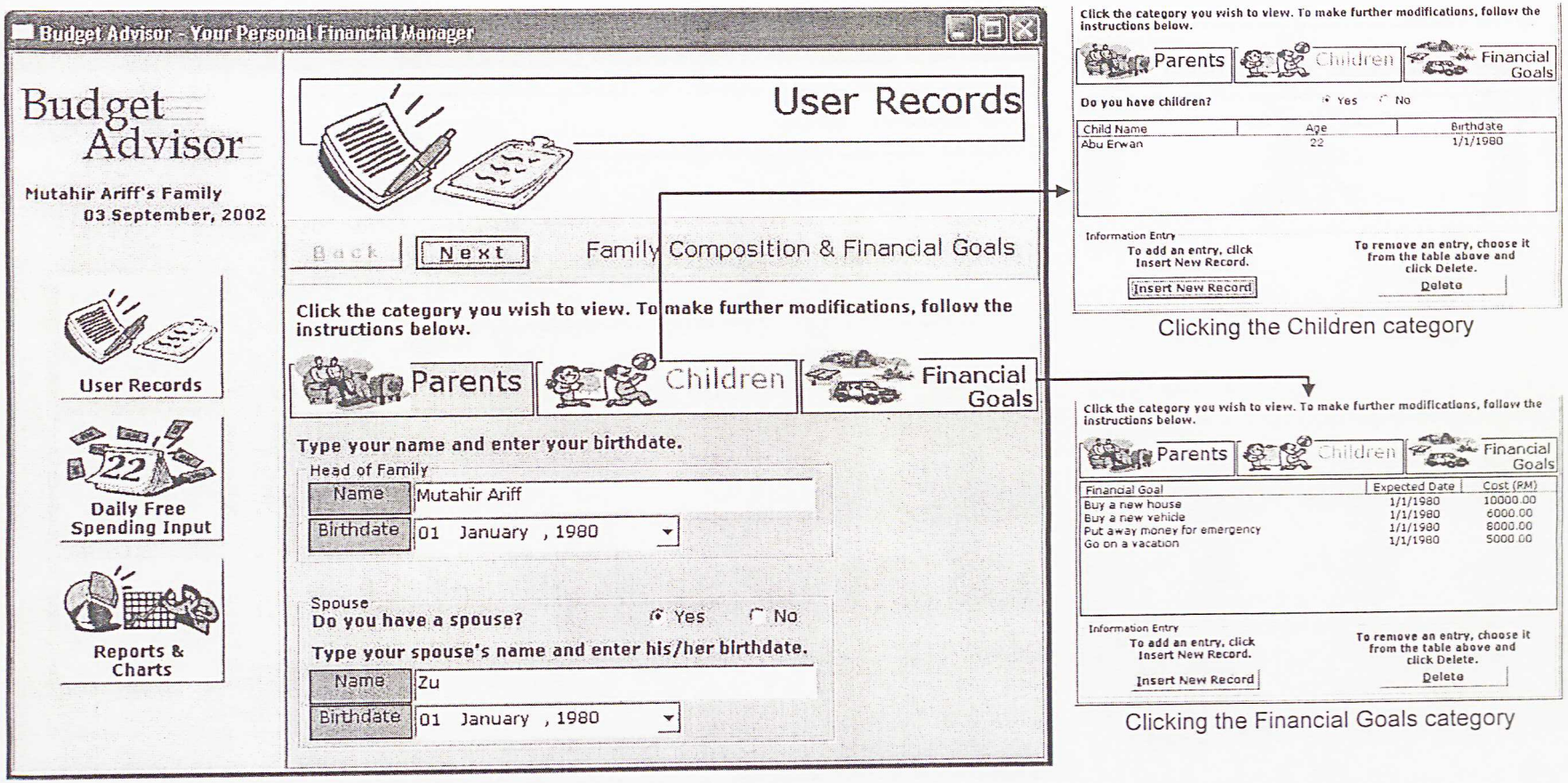

Figure 4.10 First page of **SECTION 1 - User Records – Family Composition & Financial Goals** page

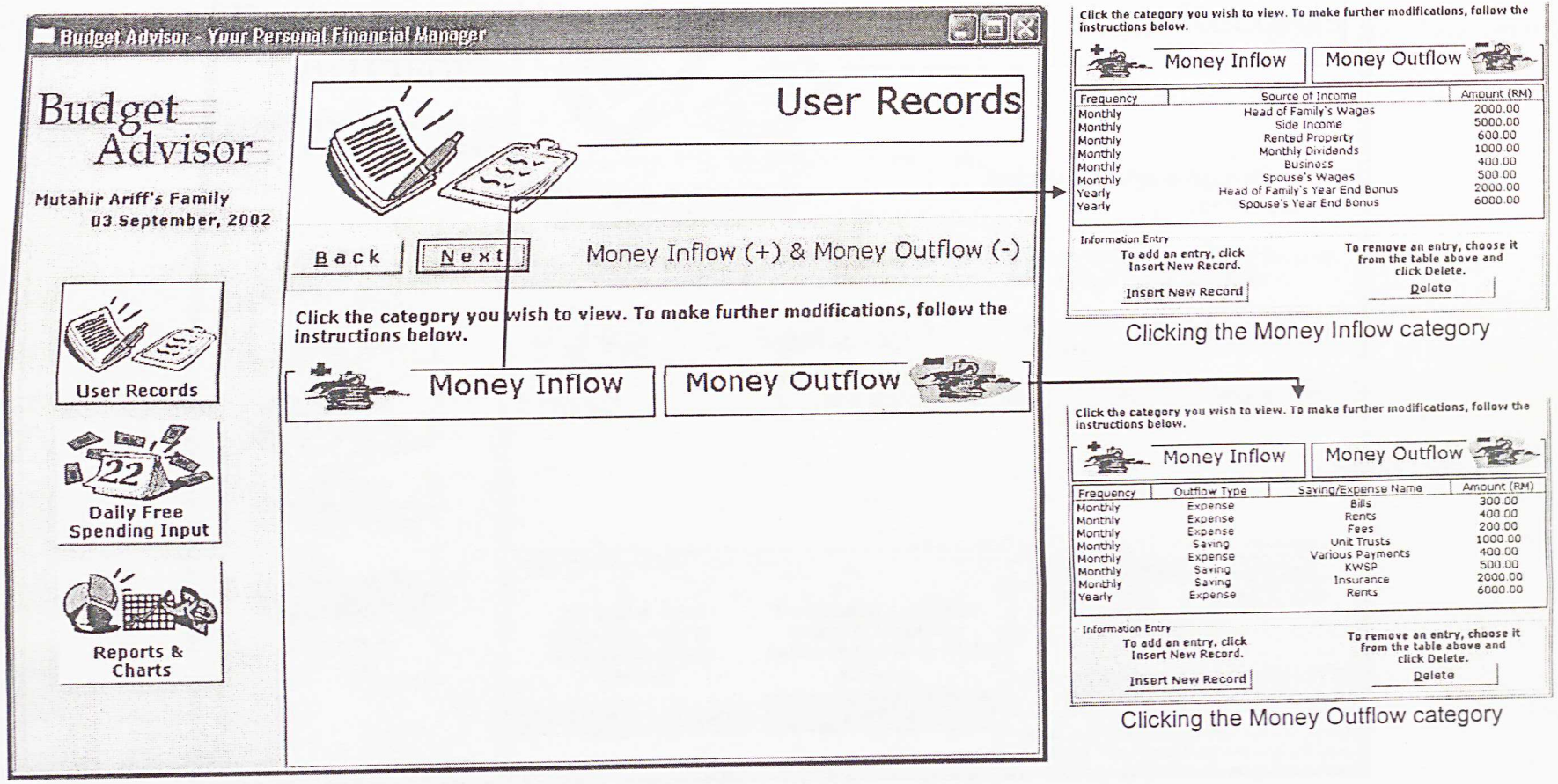

Figure 4.11 Second page of **SECTION 1 - User Records – Money Inflow (+) & Money Outflow (-)** page

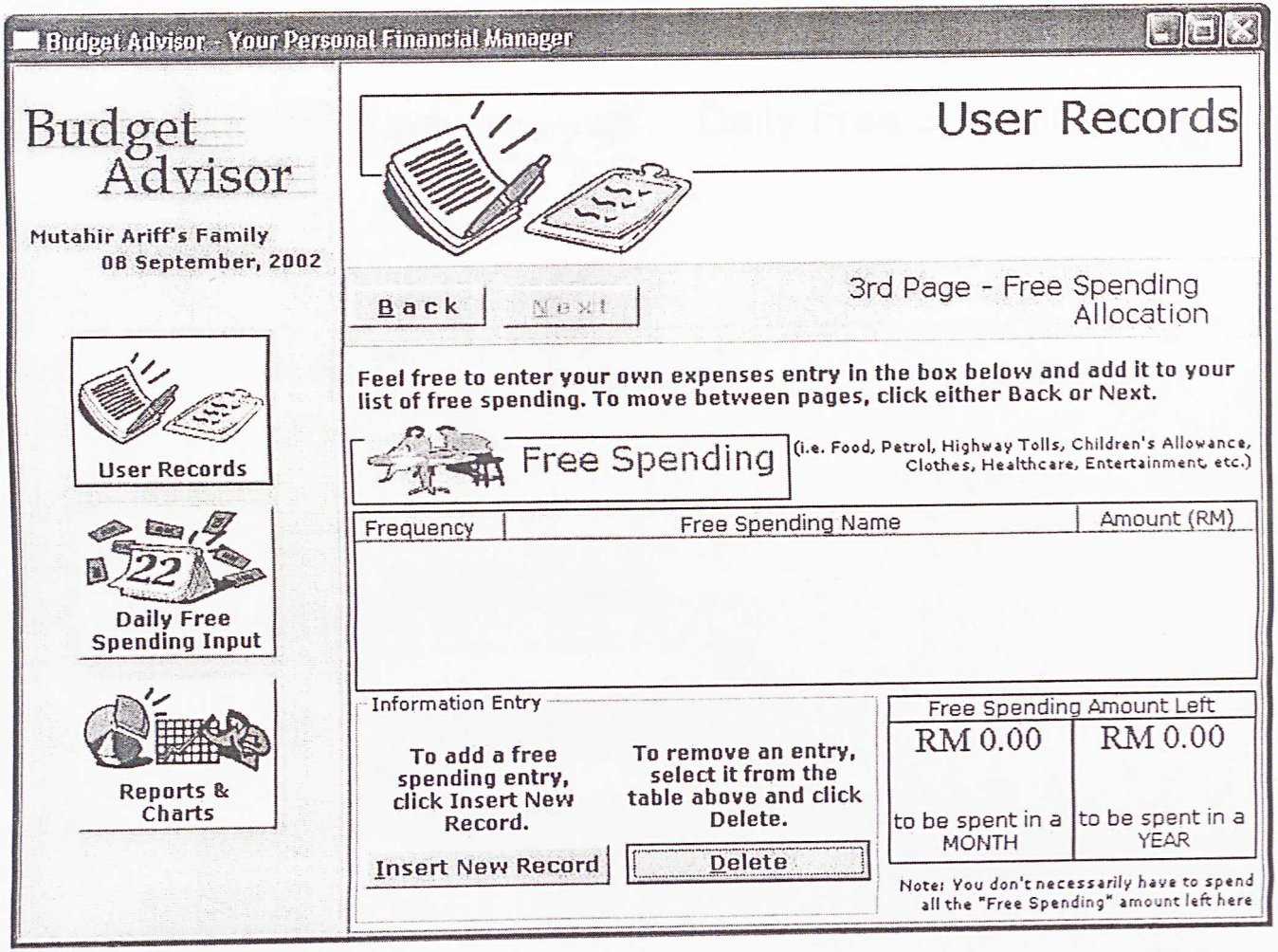

Figure 4.12 Third page of **SECTION 1 - User Records – Free Spending Allocation** page

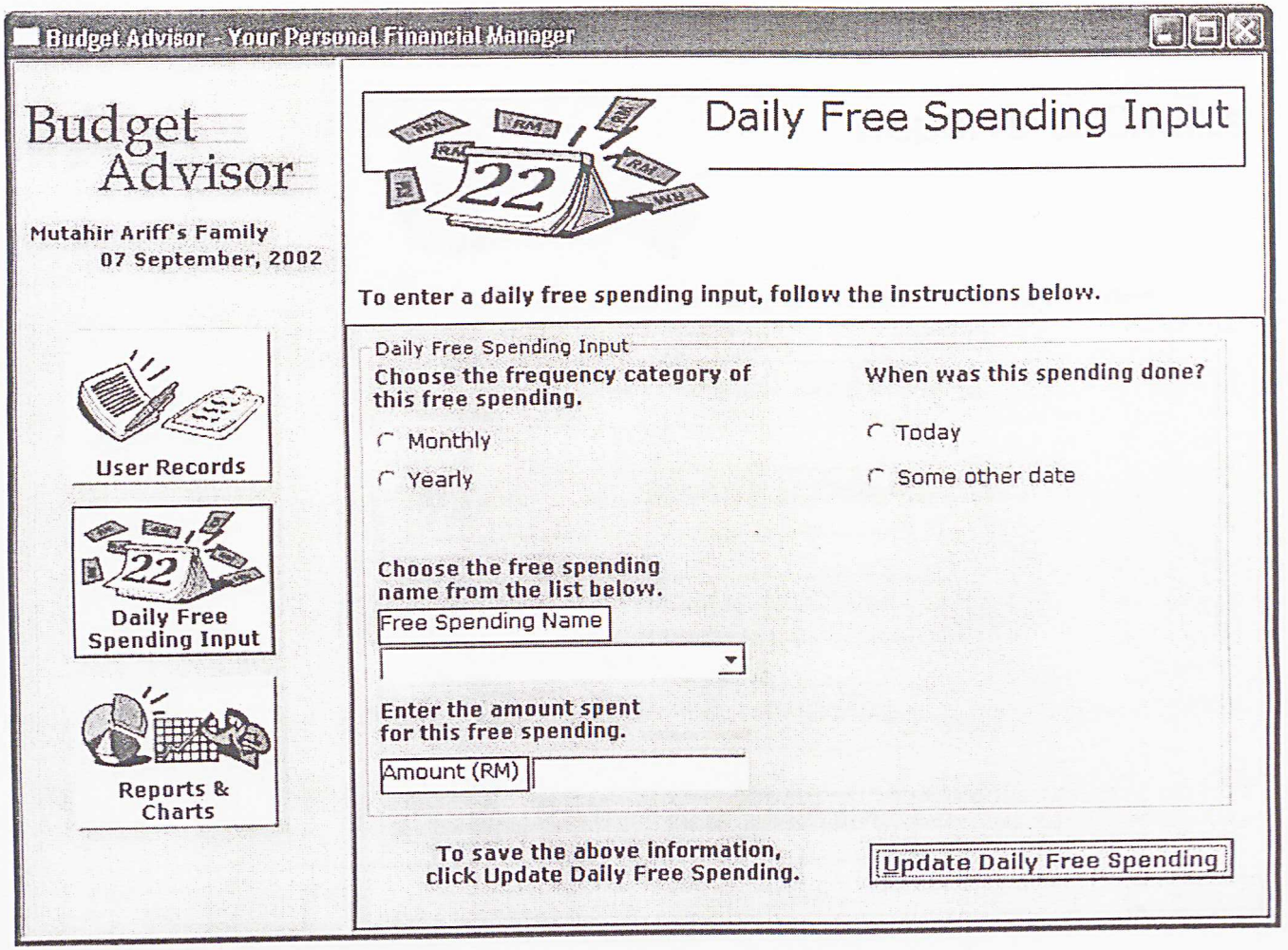

Figure 4.13 **SECTION 2 – Daily Free Spending Input**

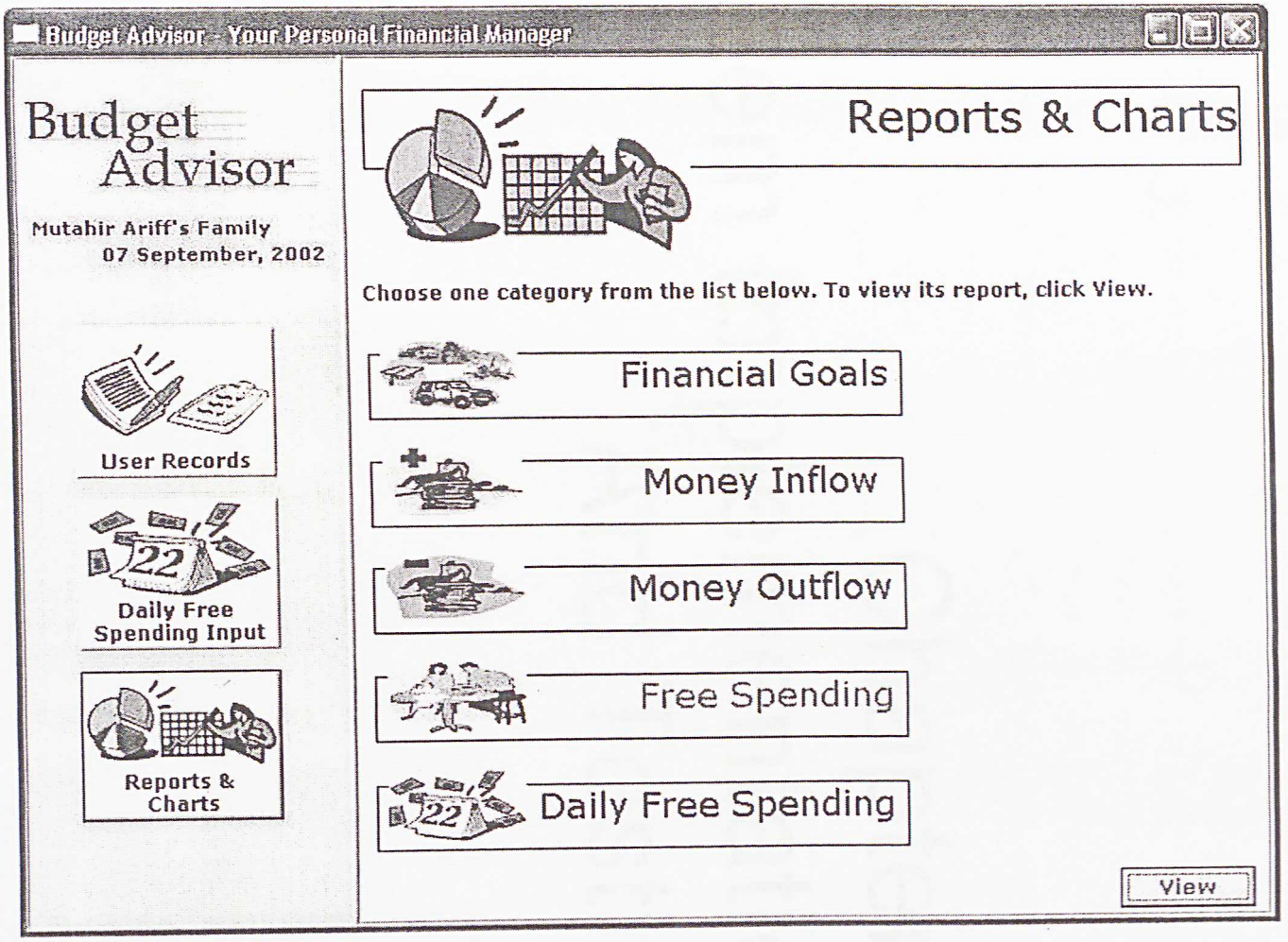

Figure 4.14 **SECTION 3 – Reports & Charts**

Chapter 5
System Implementation And Testing

Chapter 5 System Implementation And Testing

5.1 System Testing

Testing provides a method of uncovering logical error and to test the system's reliability. Hence, all of the system's newly written or modified application programs, as well as new procedural manuals, new hardware, and all system interfaces must be tested thoroughly. Testing is done throughout the entire course of the system development, and is not only subjected to be conducted at the end only. It is far less destructive to conduct testing earlier in the development stage than to have a poorly tested system fail after installation when it is in the user's hands. Such an occurrence would result in waste of time, cost and effort. A successful testing would result in quality produced software that is few in errors and works according to specifications and user requirements. In developing a system, testing usually involves several stages.

5.1.1 Unit Testing

Unit testing concentrates on the smallest component of the system for testing. Each individual component developed in a system is tested independently and apart from other system components, ensuring that they operate as intended on their own.

During testing, the program is checked to verify that the routine works as it had been written. Succeeding this, valid and invalid data are created and tested against the routine, hoping that it catches any unseen errors. Upon getting satisfactory outputs from the main module, we will proceed to test other modules by adding more test data that conforms to it. Verification of the output from a certain test data must be carried out carefully, the mistake of assuming that data contained in a file is correct just because a file was created and accessed should be avoided. Invalid data is included in testing to ensure that the system can

properly detect errors. Two types of unit testing are applied to this project, namely, white box testing and black box testing.

5.1.1.1 White Box Testing

White box testing involves the task of analyzing the code and using one's knowledge about the structure of a component to derive test data. The advantage of white box testing is that analysis of the code can be used to find out how many test cases are needed to guarantee a given level of test coverage. The tests covered under this phase includes basic path testing, data flow testing, path testing and loop testing.

5.1.1.2 Black Box Testing

Black box testing involves the task of studying the inputs and related outputs of a test object to determine its behaviour. The advantage of this kind of testing is that the use of a black box would free itself from the constraints imposed by the internal structure and logic of the test object. The disadvantage is that it is not always possible to run a complete thorough test in this kind of way. Among the tests conducted during this phase are boundary value analysis, error guessing and domain testing.

5.1.2 Integration Testing

When all components have gone through unit testing, the next step is ensuring that the interfaces among the components are defined and handled properly. This step is called integration testing, also known as module testing, which aims to verify that all components work together as described in the module or system design specifications.

The order in which components are tested here affects our choice of test cases and tools. The system is viewed as a hierarchy of components, where each component belongs to a layer of design. In this system, the top-down integration approach is used, where testing begins from the top, and working down to the levels below. This process is continued until all modules are tested.

5.1.3 System Testing

The last testing phase is system testing which is performed to uncover a system's limitations, measure its capabilities and make certain that the whole system works according to user's specifications. Developers will work out with the users to during this phase where the system is checked against the user's requirement specification. If the users are satisfied with the system, then it is assured that the product is now ready to be released for use. The results from the testing will determine whether or not the entire system specification and objectives are achieved.

5.1.3.1 System Test Considerations

In system testing, not only does the behaviour of the individual functions need to be tested, further functional tests also involves the following:-

- **Event List** All the possible triggers is exercised and the expected results are compared with the actual results. Every function is tested by one or more events in the events list.
- **Error Message Testing** Every error message, which are included in the system are extracted from the code and placed in a table to be tested for appropriateness and understandability. On top of that, they are also checked against a 'national language' perspective to see that they have enough room for displaying in both the table and onscreen if it were being translated.

- **Documentation Testing** Each example shown in the user's manual are checked to ensure its correctness.

5.1.3.2 Fundamental Tests (Product Verification Testing)

In addition to the functional tests based on functional behaviours defined above, there are other tests fundamental to all software. Several of them are difficult to measure accurately. To name five of them:-

- **Usability** The usability should be based against building user interfaces that have patterns already familiar to the typical user. The user then learns to use the software through pattern matching and paradigm shifts, exactly as they do in mastering any product.
- **Installability** This measures how easy it is for a novice to install the software correctly and easily, without outside reference say from an expert or user manual.
- **Reliability** Reliability tests are conducted according to mathematical models of software reliability to gauge the probability of a particular function of the system to fail within a specified time. Reliability and consistency testing go hand in hand where the system behavior (inputs, outputs and response time) is measured for consistency.
- **Performance** Performance tests are conducted to ensure that the system response time meets the user's expectations and does keep up to the earlier specified performance criteria under heavy stress or volume. During these tests, response time and the transaction rate are measured; its purpose is to test-run the performance of various functions of the software within a specified hardware configuration. Often this test can be coupled with stress testing.
- **Serviceability** This test relates to the ability of the support personnel in acquiring enough information to enable the maintenance organization to

assess the error and fix it without additional information in the event that the user's application crashes.

In conclusion, a visual representation of the steps taken in system testing is shown as in Figure 5.1 below.

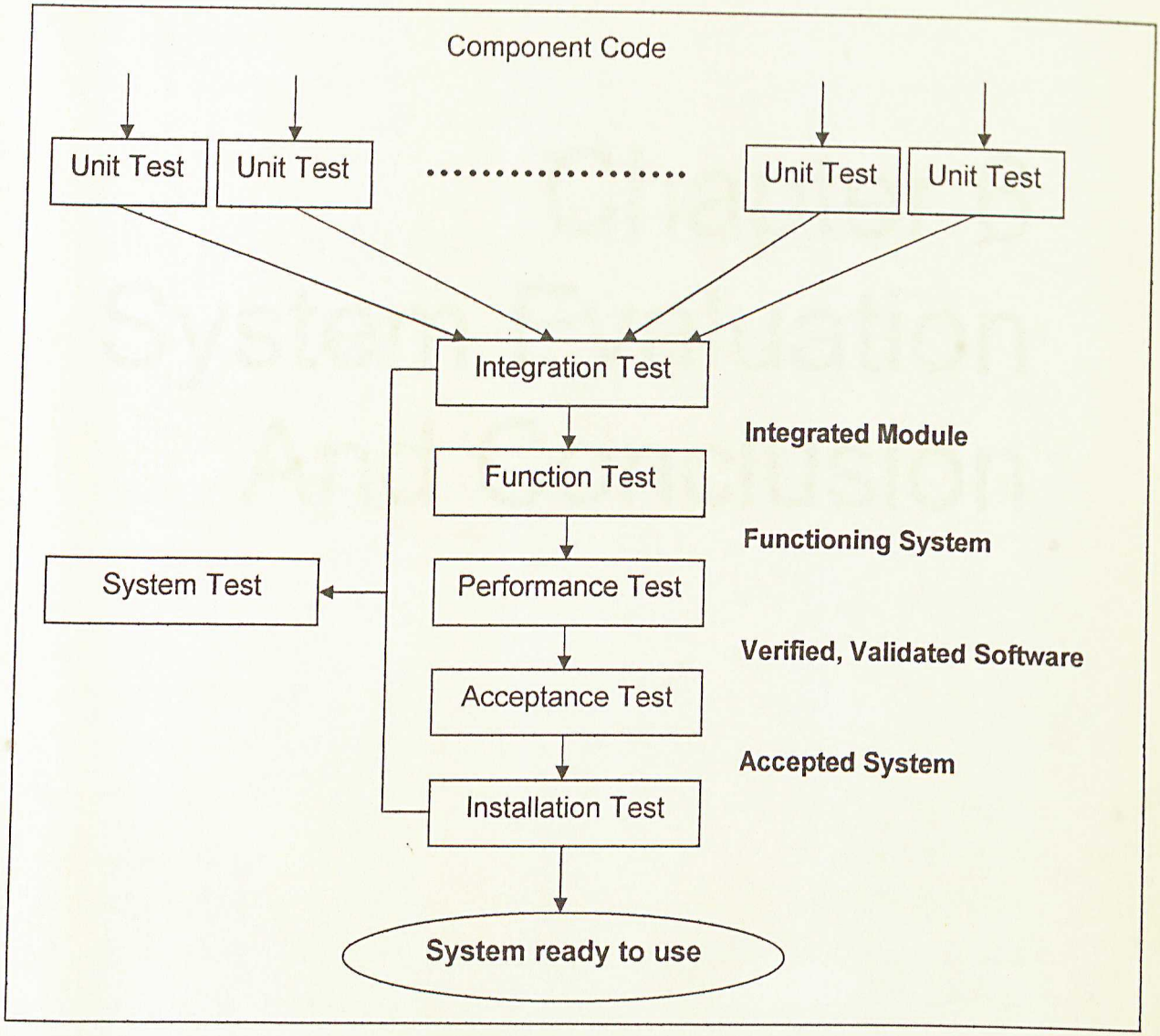

Figure 5.1 Steps taken in System Testing

Chapter 6
System Evaluation And Conclusion

Chapter 6 System Evaluation And Conclusion

6.1 System Evaluation

6.1.1 Problems Encountered and Solutions Recommended

As with other projects, during the development of Budget Advisor, I did encounter problems which unfolded one after another as the development progressed.

6.1.1.1 Problem Encountered During Analysis Phase

Determining the Scope of the System

The extent to which this project will be developed was quite hard to come upon, considering that I have no prior experience in developing one. Several matters was taken into consideration, one of them being the fixed time frame given for its completion. To overcome this, I studied the capabilities Visual Basic together with the other softwares used, concluding in the final scope decided for the project.

6.1.1.2 Problem Encountered During Design Phase

Time Constraint

During the design phase, there was not enough time to study and produce the best solution for the system design. For the record, the design phase was conducted during Projek Ilmiah 1, which spanned the course of only 40 days ("Semester Khas" 2001-2002). I find this problem can mainly be attributed to inexperience and insufficient knowledge. This was not helped by the low transparency regarding the design of the many systems found during literature review. Hence, the best system design that could be produced was found

through compiling the many previous year student's report documentation, taking in the good aspects in each of them.

6.1.1.3 Problem Encountered During Coding Phase

Data Not Synchronized On Time

This was a problem that I could not come up with a solution. The problem here involves the synchronization of data between the User Records section and the Report & Charts section, in which data is not immediately synchronized after any modification has been in the former section; if the user happen to view the latter section, the older unmodified data would be displayed. The only solution left for the user would be to close the program and start it again, only then would the modified data be updated and viewed accordingly in the Report & Charts section.

6.1.1.4 Problem Encountered During Testing Phase

Inefficiencies In the Program

I discovered that the program's performance is lagging and inefficient, although this is considered a minor problem and not far disastrous as to affect the user's data integrity. This problem might be attributed to the way the program was written, which was quite unprofessional in its layout and use of controls, resulting in the degrade in performance while executing it. Redundant functions and calls were many and present throughout the code. In conclusion, I don't think there is a clear solution to this other than to hope that processing power is evident on the user's side.

6.1.1.5 Problem Encountered During Implementation Phase

Package and Deployment

There were problems encountered during the process of preparing the software package. The software package is important as it enables ease of installation for the user upon receiving the software. Although there are other package deployment software available, I did not decide to immediately try an alternative one than the one used (bundled together as one of the tools with Visual Basic 6.0 as the "Package & Deployment Wizard). I assumed that the abrupt halt in creating the package was due to a faulty version of Visual Basic (mine was a pirated copy). Other than that, it may be because of conflicting versions, since Crystal Reports was embedded in developing Budget Advisor, and the version that I used was version 8.5. Since no error message or error log was given, it was hard to determine this for sure. In the end, this problem was overcame by installing Visual Basic Service Pack 5 that was up for download at the Microsoft support website. Thus, the software package was able to be produced.

NOTE:- Although it appeared that the above solution succeeded in solving this problem, another problem came up during installation of the software; in which the software could not be installed completely. Thus this problem still holds and I have decided that the Budget Advisor will not have a software package deployment included.

6.1.2 System Strengths

Although I found that Budget Advisor lacks in many aspects to some extent, it nonetheless still displays some strengths of its own, listed here in the following:-

- **Simple and Understandable Execution** I found that the working of this program is very straightforward, meeting the user requirement that it should be as simple and concise as possible. The guides present at almost every part of the program will prove to be helpful for the novice, and I do believe that one might not need to refer to the manual often with these guides present. The interface has also been designed to minimize any clutter and is flushed with distinct colours appropriate with the various content being shown.
- **Helpful and Guided All Around** Novice users are prone to make errors, but with error messages and warnings, filtered and controlled inputs on characters that are allowed to be entered and also pre-defined options, it would assist these users a lot in using the software.

6.1.3 System Limitations

The limitations that exist in this system are many, but unfortunately could not be remedied upon considering the time constraints given. Perhaps future revisions and updates might be able to overcome the following limitations:-

- **Advise Not Present** Despite this program being called 'Budget Advisor' it does not do much in advising the user regarding their finances. What it does is presenting the user with reports and charts that will help the user in determining the best course for his/her financial situation; in other words, the advice aspect is left for the user to come up with on their own. I find this to be a big loss of feature for the Budget Advisor, but in the course of solving this limitation, it is apparent that the solution is not easy

to be developed. The experience and skill in creating a good artificial intelligence that would interact with the user, give timely and appropriate responses and such is out of my knowledge base. To note, such an artificial intelligence capability is hard to come up with considering that the input from the user varies and is quantitative in nature.

- **Low Level of Customization** The generated reports and charts do not offer a customization feature to it, and is already pre-tailored to view only certain information. The user is not allowed to format it into different forms for viewing (i.e. bar graphs or line graphs). Such feature is present in powerful personal financial management softwares such as Microsoft Money and Quicken Deluxe, a good feature I might say, but one that requires careful planning and implementation. This limitation can be attributed to not fully understanding the capabilities of the reporting software (Crystal Reports 8.5) that was being used.
- **Unavailable User Menu and Help** Although the user is able to navigate through the program with ease with the help of the guides, the lack of a user menu can be a drawback. A user menu is useful for those who find it more helpful and is the best way to go about in working one's way through a program. Furthermore, there is also no Help file that can be referred to in the event the user is stuck with a certain task that has got them stumped.
- **Unavailable Web Integration** There is a lot to be said regarding the lack of web integration in this software. To extend this program and have it implemented online would mean that the scope of the project would have to be expanded; a lot of planning is required and nonetheless, it would also amount to a long time for its completion. The deployment of this application on the web would be meaningless if it just supported the interaction between the user and the application. To make full use of its presence on the web, it must be integrated and linked among the crop of websites that offer financial content and services. Take note that such

websites are very little in number here in Malaysia. That being said, I do find that the implementation of Budget Advisor away from the standalone platform at the moment onto the internet is feasible, provided it will be carried properly and benefit the full capabilities of the web.

- **Unsynchronized Data Between Records and Reports** This is present between two sections in the program, namely the User Records section and the Reports & Charts section. Please refer to **6.1.1.3 Problem Encountered During Coding Phase** above.
- **Redundant Data In User Records** Redundant entries in most tables of the database exists; that is, no control is included to prevent entries that have the same name.

6.1.4 Future Enhancements

There were many features that were overlooked upon and also some which were omitted because of several reasons (time constraint and inexperience are the two main reasons), and being the developer, I am the least satisfied with these setbacks present in the program. Several suggested recommendations on the enhancements that can be made on Budget Advisor in the future are as follows:-

- **Revised Reporting** I hope that the reporting style currently implemented could be enhanced (have more details and a summarization to it) and enable the user to customize it more freely (users will be able to change the type of report generated and also choose which fields he/she wishes).
- **Improved Interaction With the User** I would love to see the program to give more interactive content to the user, such as advice and recommendation from time to time, and have the user give his/her feedback on it.

- **Added Support for Web Integration** More research needs to be done on the many sites offering financial content and services locally, and I hope with such information from the research, the Budget Advisor could be modified to offer efficient web integration. I would love to see the Budget Advisor having a personalized user financial page deployed on the web just like other softwares in the same category namely MS Money and Intuit's Quicken (see Chapter 2: Literature Review page 18 and page 20). Having said this, it would require full backing from said local financial sites in order to achieve this daunting task of including such a feature.
- **Fully Documented** The Budget Advisor has not been fully documented (both technical and user-end) when it was handed in, thus it might be difficult for future revisions to be done against it. I would hope for it to be documented properly in the future, especially the sourcodes that was previously mentioned to be inefficient.
- **Increased Efficiency In Code Execution** As mentioned in the point above, excellent documentation on the sourcecodes would make it possible for someone much more skilled in programming than me to make enhancements and streamline the code execution, thus increasing its efficiency (Please refer to **6.1.1.4 Problem Encountered During Testing Phase**).

6.2 Project Conclusion

Overall, this project has achieved to deliver the Budget Advisor in time and fulfilled most of the objectives and requirements as specified during the system analysis phase.

Throughout the course of developing the Budget Advisor, there were a lot of valuable knowledge and experience gained. As the project progressed and being built up, so did my insight on the world of personal financial management, how IT and the internet has come to change and shape new ways for people to manage their finances, programming concepts, how to design a good user interface using various computer graphic tools and also professional reporting and information presentation. I have come to use various softwares (some of which I have never even used before) in developing this project, honing my skills in using them and exploiting the many features that prove to be valuable and not to mention effective. These software are namely Microsoft Visual Basic 6.0, Microsoft Access, Adobe Illustrator 10.0, Adobe Photoshop 6.0 and Flash MX. I am looking forward to exploring their features further and hoping to use them to the fullest in any future projects.

While acquiring technical skills in using software are essential, good practice in software engineering techniques had also been applied by undertaking this project. Through this project, I have seen how the techniques, paradigms and approaches learned in my Computer Science courses (namely System Analysis and Design and Software Engineering) can be applied in a real software development environment. It is thus a golden chance for me to experience this applied in actuality.

Lastly, I feel there is still more room for improvement in this system. As mentioned before, the system scope was defined through the waterfall model with prototype, making the system highly expandable in terms of functionality. Future enhancements as explained previously could still be made.

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Appendix
Budget Advisor
User Manual

Budget Advisor User Manual

⌗ Contents

This user manual contains the following topics.

Section 1
Program Overview

The User Interface

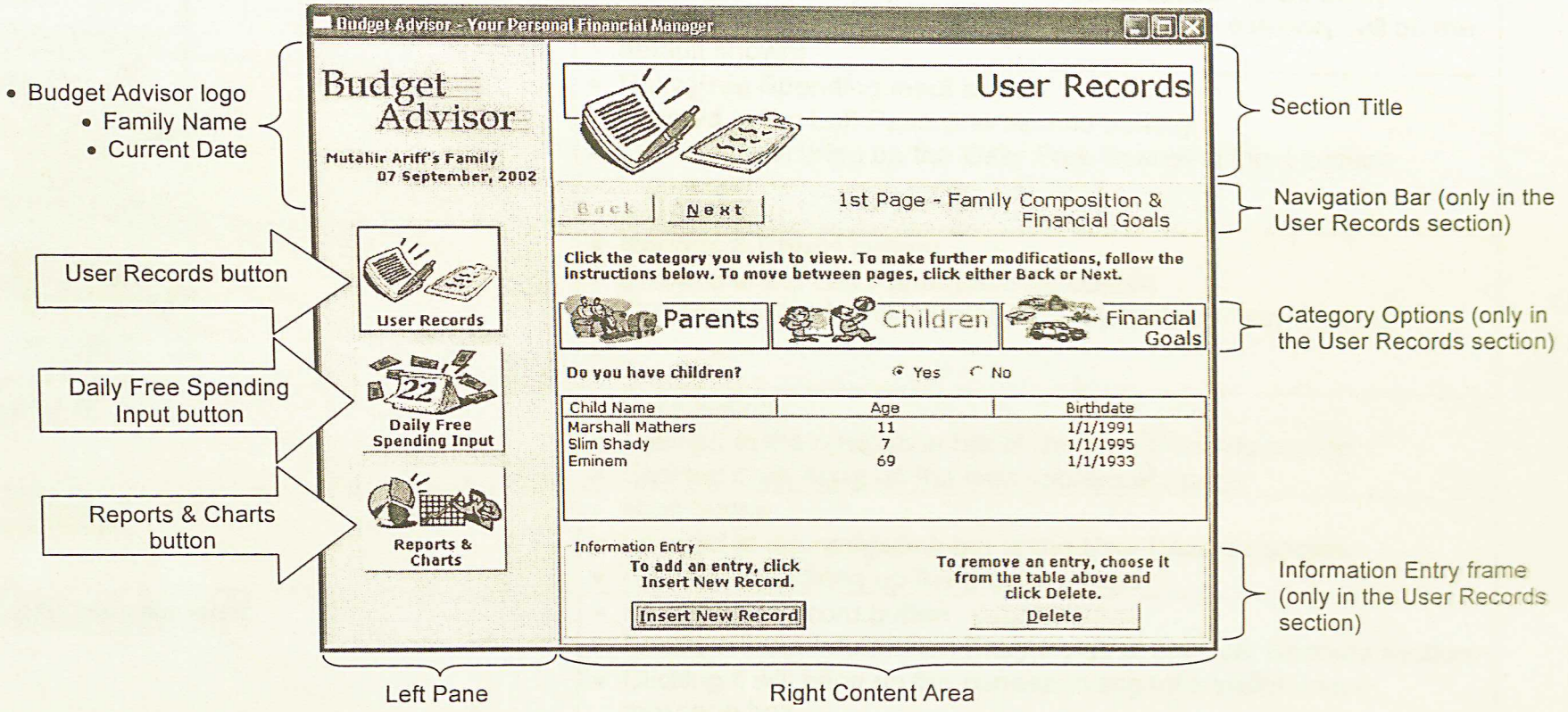


Figure A The Budget Advisor User Interface

Objects Table

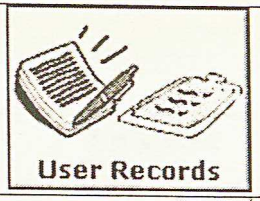
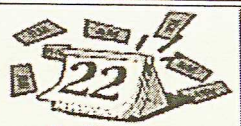
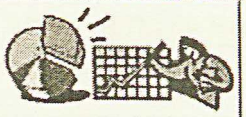
Object	Description
	• User Records button. • Located at the Left Pane (the first button) • Clicking it will bring up the User Records section (the Family Composition & Financial Goals page – Parents category will be the default shown)
 Daily Free Spending Input	• Daily Free Spending Input button. • Located at the Left Pane (the second button) • Clicking it will bring up the Daily Free Spending Input section
 Reports & Charts	• Reports & Charts button. • Located at the Left Pane (the third button) • Clicking it will bring up the Reports & Charts section
Back	• Back button • Located in the navigation bar of the User Records section • Clicking it will bring up the next subsequent page
Next	• Next button • Located in the navigation bar of the User Records section • Clicking it will bring up the previous page
Insert New Record	• Insert New Record button • Located in the Information Entry frame of the User Records section • Clicking it will bring up the corresponding Information Input message box

Table A Objects Table

Object	Description
Delete	• Delete button • Located in the Information Entry frame of the User Records section • If an entry is chosen in the table above it, click it will remove the entry from the table and user records
Insert	• Insert button • Located in all Information Input message boxes • Clicking it will save the information entered in the message box
Cancel	• Cancel button • Located in all Information Input message boxes • Clicking it will cancel all information entered and exit from the message box
Update Daily Free Spending	• Update Daily Free Spending button • Located in the Daily Free Spending Input section • Clicking it will save the daily free spending information entered
View	• View button • Located in the Reports & Charts section • Clicking it will bring up the corresponding report and chart highlighted from the reports and charts options
Close	• Close button • Located in the Reports & Charts section • Clicking it will close the report and chart that is being displayed

Table A Objects Table (continued)

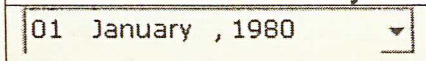
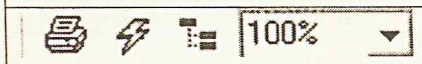
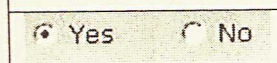
Object	Description
	• Date picker control • Located in certain categories and message boxes in the User Records section • Clicking the arrow on the right side will bring up a pop up month calendar from which to choose the date from
	• Report Viewer buttons (from left Print, Refresh, Navigation Pane and Zoom) • Located above the report and chart displayed in the Reports & Charts section • Clicking it will perform various functions as explained below o **Print button** – prints the report and chart that is currently being shown o **Refresh button** – refreshes the report and chart (useful in the instance that the report and chart are not displayed in full) o **Navigation Pane button** – displays the navigation pane on the left side of the report and chart o **Zoom button** – changes the magnification of the report according to the zoom percentage chosen (click the arrow on the right side will bring up a pop up zoom percentage values from which to choose from)
	• Yes No radio buttons • Located in the Parents and Children categories in the User Records section • Clicking it will chose the option indicated by the label

Table A Objects Table (continued)

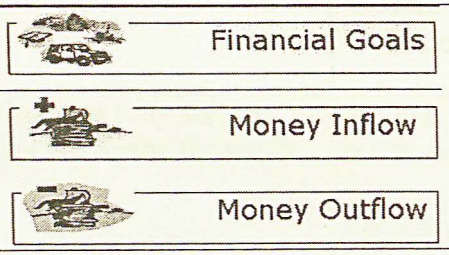
Object	Description
○ Monthly ○ Yearly	• Monthly Yearly radio buttons • Located in certain message boxes in the User Records section • Clicking it will chose the option indicated by the label
	• Category Options labels • Located in the User Records section • Clicking it will display the corresponding content indicated by the label
	• Category Options labels • Located in the User Records section • Clicking it will highlight the label. For further information, see the View button above.

Table A Objects Table (continued)

Section 2
Program Walkthrough

This section will provide you with a thorough walkthrough of the program.

User Records

<table>
<tr><th>IF the user...</th><th>THEN...</th></tr>
<tr><td>Opens the program for the first time.</td><td>• The Attention page will be displayed.
• To set up the User Records, click the Go To User Records button.
• The Parents category page (purple in colour) will be displayed.
• Proceed to the “Parents Category” subsection below.</td></tr>
<tr><td>Has not fully set up his/her User Records.</td><td>• The Attention page will be displayed.
• To set up the User Records, click the Go To User Records button.
<table>
<tr><th>IF the ... record has not been set up</th><th>THEN ...</th></tr>
<tr><td>Children</td><td>• The Children category page (orange in colour) will be displayed.
• Proceed to the “Children Category” subsection below.</td></tr>
<tr><td>Financial Goals</td><td>• The Financial Goals category page (lime green in colour) will be displayed.
• Proceed to the “Financial Goals Category” subsection below.</td></tr>
</table>
</td></tr>
</table>

Table B User Records

User Records (continued)

<table>
<tr><th>IF the user...</th><th>THEN...</th></tr>
<tr><td>Has not fully set up his/her User Records.</td><td>
<table>
<tr><th>IF the ... record has not been set up</th><th>THEN ...</th></tr>
<tr><td>Money Inflow</td><td>• The Money Inflow category page (aqua blue in colour) will be displayed.
• Proceed to the “Money Inflow Category” subsection below.</td></tr>
<tr><td>Money Outflow</td><td>• The Money Outflow category page (fuchsia red in colour) will be displayed.
• Proceed to the “Money Outflow Category” subsection below.</td></tr>
<tr><td>Free Spending Allocation</td><td>• The Free Spending Allocation category page (yellow in colour) will be displayed.
• Proceed to the “Free Spending Allocation Category” subsection below.</td></tr>
</table>
</td></tr>
</table>

Table B User Records (continued)

User Records – Parents Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>Head of Family Information Input
• Enter the name of the head of family.
• Enter the birthdate of the head of family.</td></tr>
<tr><td>2</td><td>Choose one of the radio button (Yes or No) to specify whether you have a spouse or not.

<table>
<tr><th>IF the user chooses ...</th><th>THEN ...</th></tr>
<tr><td>Yes</td><td>• The Spouse Information Input will be enabled.

Spouse Information Input
• Enter the name of the spouse.
• Enter the birthdate of the spouse.
• Proceed to Step 3.</td></tr>
<tr><td>No</td><td>Proceed to Step 3.</td></tr>
</table>
</td></tr>
<tr><td>3</td><td>• Click the Children category label.
• The Children category page (orange in colour) will be displayed.
• Proceed to the “Children Category” subsection below.</td></tr>
</table>

Table C Parents Category

User Records – Children Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>Choose one of the radio button (Yes or No) to specify whether you have children or not.
<table>
<tr><th>IF the user chooses ...</th><th>THEN ...</th></tr>
<tr><td>Yes</td><td>• The Children Information table and Information Entry will be displayed.
• Proceed to Step 2.</td></tr>
<tr><td>No</td><td>Proceed to Step 3.</td></tr>
</table></td></tr>
<tr><td>2</td><td>
<table>
<tr><th>IF the user chooses to ...</th><th>THEN ...</th></tr>
<tr><td>Add a new child entry</td><td>• Click the Insert New Record button.
• The Children Information Input message box will be displayed.
• Proceed to step 3</td></tr>
<tr><td>Remove a child entry</td><td>• Choose the child entry that is to be removed to highlight it.
• Click the Delete button.</td></tr>
</table></td></tr>
</table>

Table D Children Category

User Records – Children Category (continued)

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>3</td><td>Child Information Input
• Enter the name of the child.
• Enter the birthdate of the child.

<table><tr><th>IF the user chooses to …</th><th>THEN …</th></tr><tr><td>Add the information</td><td>Click the Insert button. Proceed to Step 3.</td></tr><tr><td>Cancel and exit the message box</td><td>Click the Cancel button.</td></tr></table></td></tr>
<tr><td>4</td><td>• Click the Financial Goals category label.
• The Financial Goals category page (lime green in colour) will be displayed.
• Proceed to the “Financial Goals Category” subsection below.</td></tr>
</table>

Table D Children Category (continued)

User Records – Financial Goals Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>The Financial Goals Information table and Information Entry will be displayed.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add a new financial goal entry</td><td>• Click the Insert New Record button.
• The Financial Goals Information Input message box will be displayed.
• Proceed to step 2</td></tr>
<tr><td>Remove a financial goal entry</td><td>• Choose the financial goal entry that is to be removed to highlight it.
• Click the Delete button.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Financial Goals Information Input
• Enter the name of the financial goal OR choose from the drop down list.
• Enter the expected date you want to achieve this financial goal.
• Enter the cost that it would take to achieve this financial goal
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add the information</td><td>Click the Insert button. Proceed to Step 3.</td></tr>
<tr><td>Cancel and exit the message box</td><td>Click the Cancel button.</td></tr>
</table></td></tr>
<tr><td>3</td><td>• Click the Next button.
• The Money Inflow category page (aqua blue in colour) will be displayed.
• Proceed to the “Money Inflow Category” subsection below.</td></tr>
</table>

Table E Financial Goals Category

User Records – Money Inflow Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>The Money Inflow Information table and Information Entry will be displayed.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add a new money inflow entry</td><td>• Click the Insert New Record button.
• The Money Inflow Information Input message box will be displayed.
• Proceed to step 2</td></tr>
<tr><td>Remove a money inflow entry</td><td>• Choose the money inflow entry that is to be removed to highlight it.
• Click the Delete button.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Money Inflow Information Input
• Choose one of the radio button (Monthly or Yearly) to specify the frequency of this money inflow.
• Enter the source of income for this money inflow OR choose from the drop down list.
• Enter the amount received for this money inflow
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add the information</td><td>Click the Insert button. Proceed to Step 3.</td></tr>
<tr><td>Cancel and exit the message box</td><td>Click the Cancel button.</td></tr>
</table></td></tr>
</table>

Table F Money Inflow Category

User Records – Money Inflow Category (continued)

Step	Description
3	• Click the **Money Outflow** category label. • The Money Outflow category page (fuchsia red in colour) will be displayed. • Proceed to the "Money Outflow Category" subsection below.

Table F Money Inflow Category (continued)

User Records – Money Outflow Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>The Money Outflow Information table and Information Entry will be displayed.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add a new money outflow entry</td><td>• Click the Insert New Record button.
• The Money Outflow Information Input message box will be displayed.
• Proceed to step 2</td></tr>
<tr><td>Remove a money outflow entry</td><td>• Choose the money outflow entry that is to be removed to highlight it.
• Click the Delete button.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Money Outflow Information Input
• Choose one of the radio button (Monthly or Yearly) to specify the frequency of this money outflow.
• Choose one of the radio button (Saving or Expense) to specify the type of this money outflow.
• Enter the name for this money outflow OR choose from the drop down list.
• Enter the amount spent for this money outflow.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add the information</td><td>Click the Insert button. Proceed to Step 3.</td></tr>
<tr><td>Cancel and exit the message box</td><td>Click the Cancel button.</td></tr>
</table></td></tr>
</table>

Table G Money Outflow Category

User Records – Money Outflow Category (continued)

Step	Description
3	• Click the **Next** button. • The Free Spending Allocation category page (yellow in colour) will be displayed. • Proceed to the "Free Spending Allocation Category" subsection below.

Table G Money Outflow Category (continued)

User Records – Free Spending Allocation Category

<table>
<tr><th>Step</th><th>Description</th></tr>
<tr><td>1</td><td>The Free Spending Allocation Information table and Information Entry will be displayed.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add a new free spending entry</td><td>• Click the Insert New Record button.
• The Free Spending Information Input message box will be displayed.
• Proceed to step 2</td></tr>
<tr><td>Remove a free spending entry</td><td>• Choose the free spending entry that is to be removed to highlight it.
• Click the Delete button.</td></tr>
</table></td></tr>
<tr><td>2</td><td>Free Spending Information Input
• Choose one of the radio button (Monthly or Yearly) to specify the frequency of this free spending.
• Enter the name for this free spending OR choose from the drop down list.
• Enter the amount spent for this free spending.
<table>
<tr><th>IF the user chooses to …</th><th>THEN …</th></tr>
<tr><td>Add the information</td><td>Click the Insert button.</td></tr>
<tr><td>Cancel and exit the message box</td><td>Click the Cancel button.</td></tr>
</table></td></tr>
</table>

Table H Free Spending Allocation Category

Daily Free Spending Input

Daily Free Spending Input

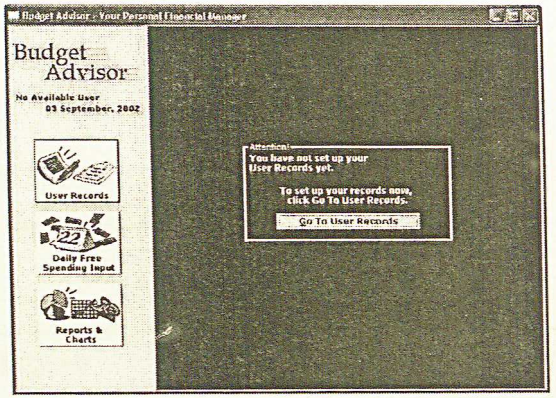
- Choose one of the radio button (**Monthly** or **Yearly**) to specify the frequency category of the free spending done.
- Choose one of the radio button (**Today** or **Some other date**) to specify the date when this free spending was done.
- Enter the name of the free spending done OR choose from the drop down list.
- Enter the amount spent for this free spending.
- To save the information entered, click the **Update Daily Free Spending** button.

Reports & Charts

- Choose one of the report labels to highlight it.
- Click the **View** button.
- The report choosed will be displayed.
- Click the **Close** button to close the report.

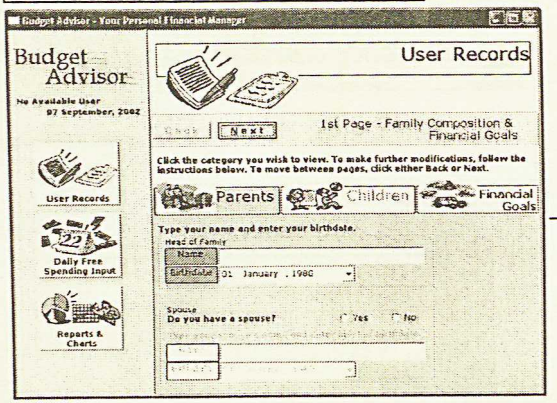
Section 3
Screen Flow

Attention Page

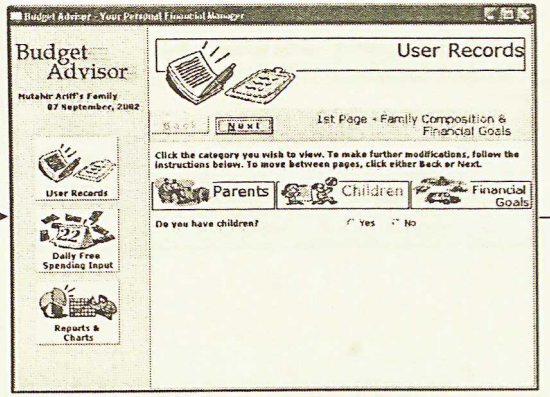


User Records section
Family Composition & Financial Goals page

Parents Category



Children Category



Financial Goals Category

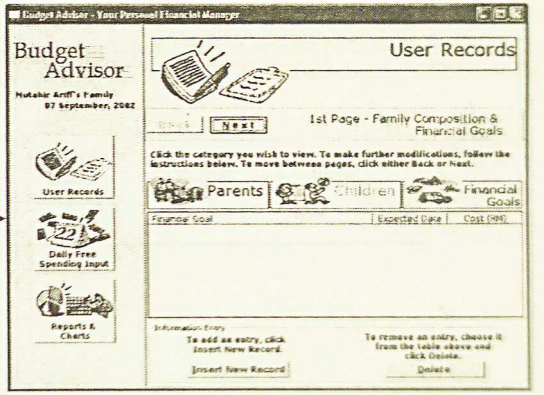


Figure B Screen Flow 1

User Records section
Money Inflow (+) & Money Outflow (-) page

User Records section
Free Spending Allocation page

Money Inflow Category

Money Outflow Category

Free Spending Allocation Category

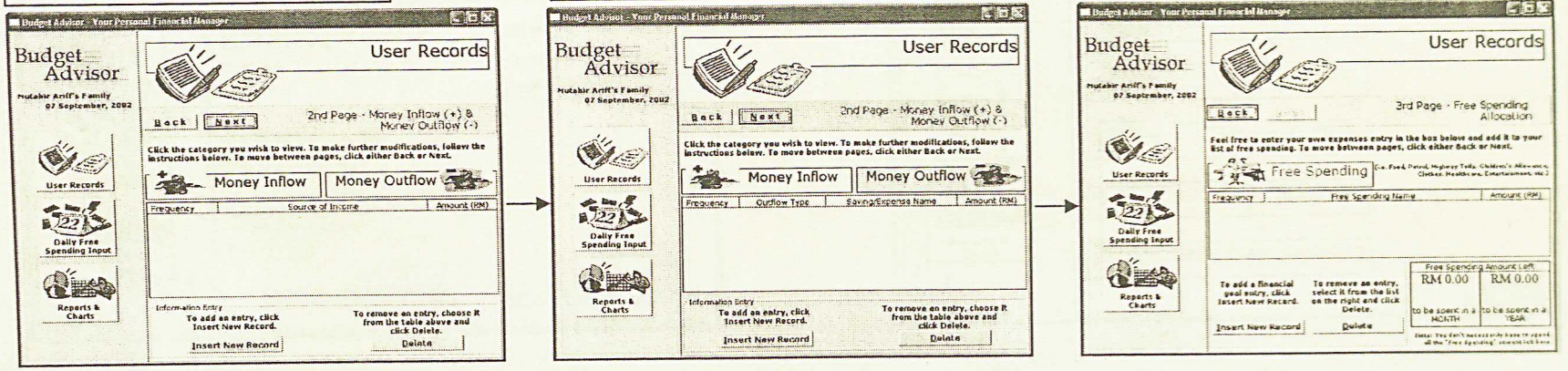
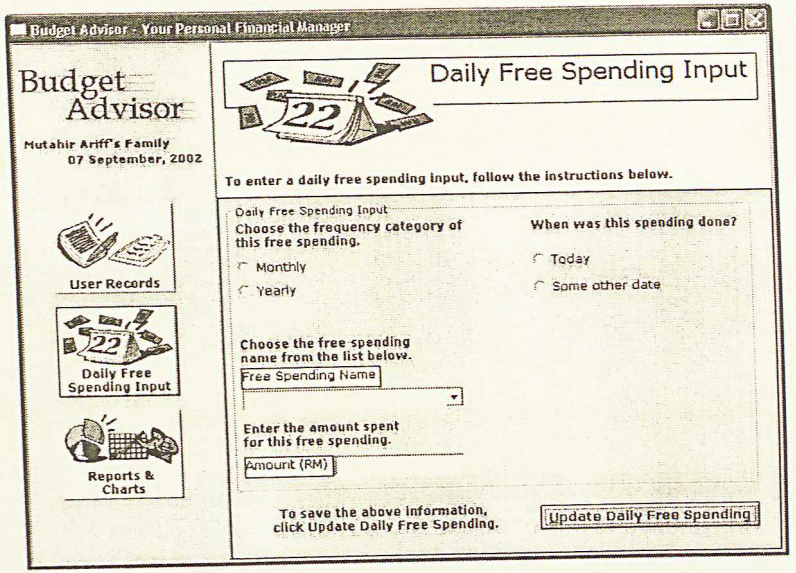


Figure C Screen Flow 2

Daily Free Spending Input section



Reports & Charts section

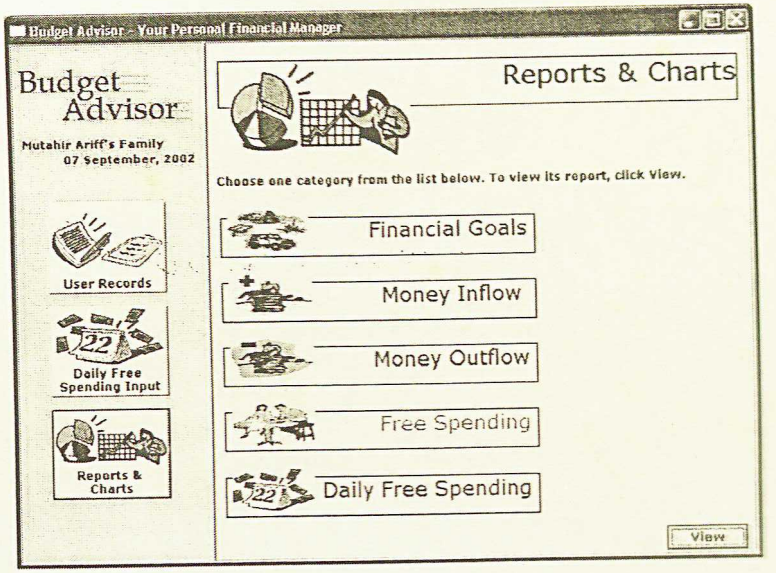


Figure D Screen Flow 3